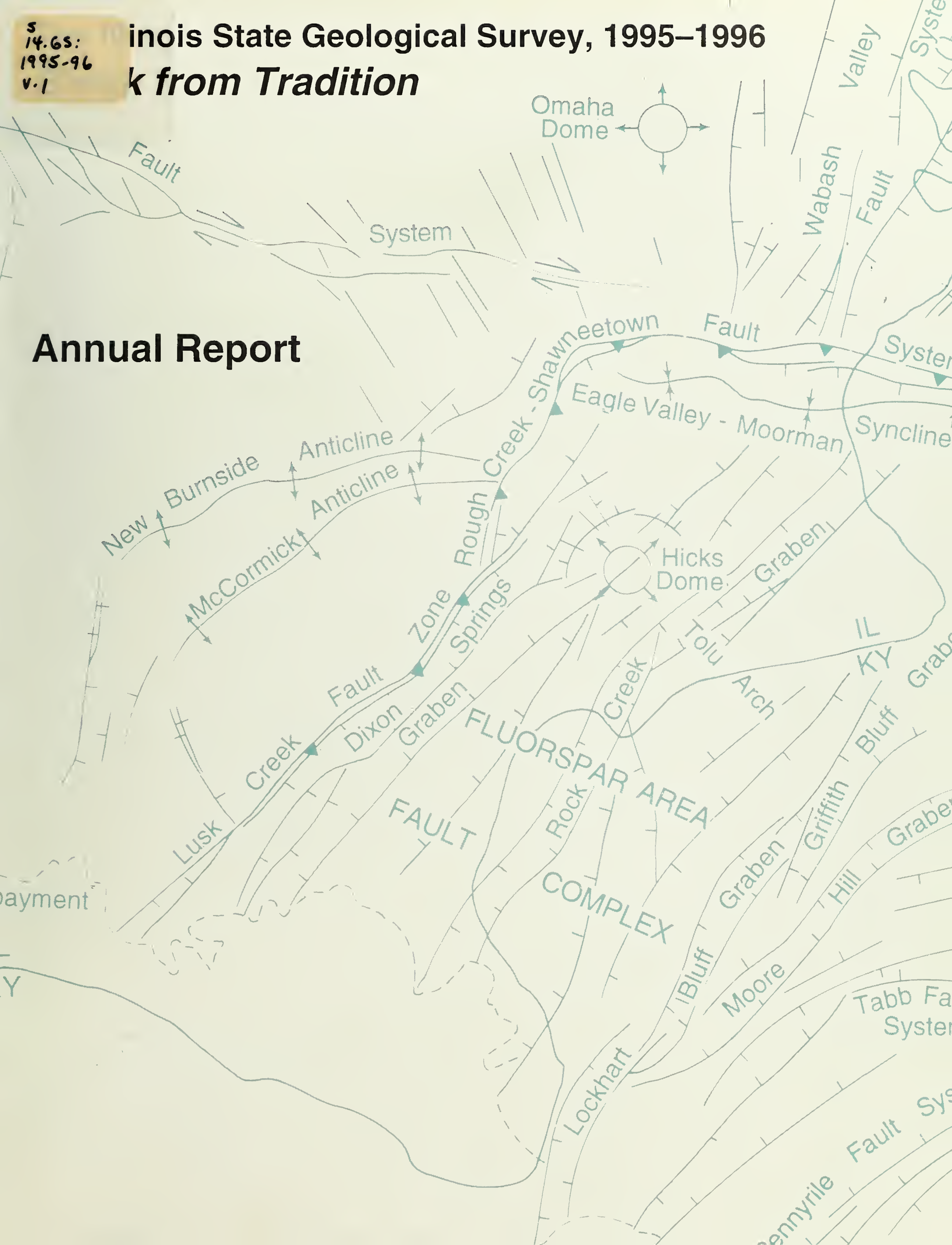
# inois State Geological Survey, 1995–1996

## *k from Tradition*

# Annual Report



# The Illinois State Geological Survey, 1995–1996

## *Break from Tradition*

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NATURAL
RESOURCES

ILLINOIS STATE GEOLOGICAL SURVEY
1905

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# To the people of Illinois

Over the past year, the Illinois State Geological Survey, with the support of our new Department of Natural Resources, has accomplished a great deal.

Ours may be the healthiest geological survey in North America. Our research is dynamic and relevant to a modern society's needs. This is largely because Survey scientists have leavened the traditional mineral- and energy-exploration core with diverse activities supporting public well-being and environmental security. I believe we owe our strong position to the wise decisions made by the Survey's leaders since the 1950s—decisions to gradually turn the Survey toward research aimed at mitigating the effects of population growth, while maintaining a strong commitment to supporting the extraction industries so important to this state.

We have embarked on significant new tasks. The initiative to map all of Illinois at a scale of 1:24,000 and in three dimensions is a top priority, long-term goal of our scientific program. In the Villa Grove and the Vincennes quadrangles, diverse groups of more than 25 scientists are working on two pilot mapping projects. The products will demonstrate the latest digital technology applied to the public's greatest needs for geologic information.

Neighboring states, as well as the U.S. Environmental Protection Agency, have expressed serious interest in the full mapping program. Talks with the U.S. Geological Survey suggest they might want to use our model as the basis for a new multimillion dollar project to support three-dimensional mapping throughout the glaciated Great Lakes states. Our own Illinois Department of Natural Resources is considering putting forward the 3-D mapping program as an initiative for next year's budget.

In minerals engineering research, we're finding new ways to convert coal to an activated char for use in scrubbing hazardous metals, sulfur dioxide, and nitrogen oxide from flue gases. New methods have also been developed for dealing with the chlorine and sulfur in coal, separating the impurities from coal, and making good use of coal fly ash.

Our work for the Illinois Department of Transportation has had a tremendous impact on the way IDOT screens infrastructure construction and reconstruction. By providing timely reports, the Survey's staff in our Savoy and regional offices earned praise from the highest levels of IDOT management.

A spectacular example of Survey expertise was our coastal geologists' widely reported documentation of the early phases of failure of a breakwater along Lake Michigan at Illinois Beach State Park. The Department of Natural Resources relayed to me their appreciation of this work in the same way that the Governor's Office informed me of our groundwater geologists' help in framing the hog-waste regulations: they said our scientists were professional, patient, excellent at explaining complex technical matters, and above all, objective in dealing with persons representing various sides of emotional issues.

Our strength is in the diversity of our skills and the breadth of our geological research; however, we must continue to inform our leaders and representatives in Springfield, as well as the general public, about our programs—in an understandable and dynamic way. We must be clear about what public purpose each of us serves and be prepared to explain it to our friends, neighbors, and the people who support us.

Difficult and important earth science problems face the people of Illinois. When they turn to us, challenge us, to help them, we will look at the challenges as opportunities to use earth science to enhance the well-being of the people of the 13th largest economy in the world—the State of Illinois.

Bill Shilts

William W. Shilts, Chief

***Glacial architecture*** *West of Champaign (lower right corner) on June 11, 1978, as viewed by the Landsat 1 Multispectral Scanner in orbit about 450 miles above Illinois. The long, curving ridges are moraines— mounds of pebbly clay, sand, and gravel that collected at the glacier's edge 18,000 to 16,000 years ago.*

# The Illinois State Geological Survey, 1995–1996
# *Break from Tradition*

**Take it from the top** Traditional methods of mapping geologic structure and materials rely on bedrock exposures, a technique that won't work where outcrops are scarce.

In most of Illinois, as Chief Bill Shilts explains, geologists work with glacial cover. That cover, also called glacial "drift," is what the last series of glaciers left between 1 million and 10,000 years ago. Nearly all the state, except for the southernmost counties and the northwestern corner, has a mantle of glacial materials ranging from as thin as a few feet to as thick as 500 feet.

Like a machine that crushes rock, a glacier grinds out sediment. Glaciers produce soil materials by physical rather than chemical weathering processes. In old chemically developed soils, many nutrients are processed out. But in younger mineral-rich soils developed in glacial materials, the inorganic base supports organic abundance. That's why the glacial boundary roughly outlines the richest agricultural land throughout the country.

Sand, gravel, silt, clay—the glacial materials—are all too often thought of as something to be stripped away so we can see the hard rock underneath and get to the coal, oil, construction stone, and other mineral resources.

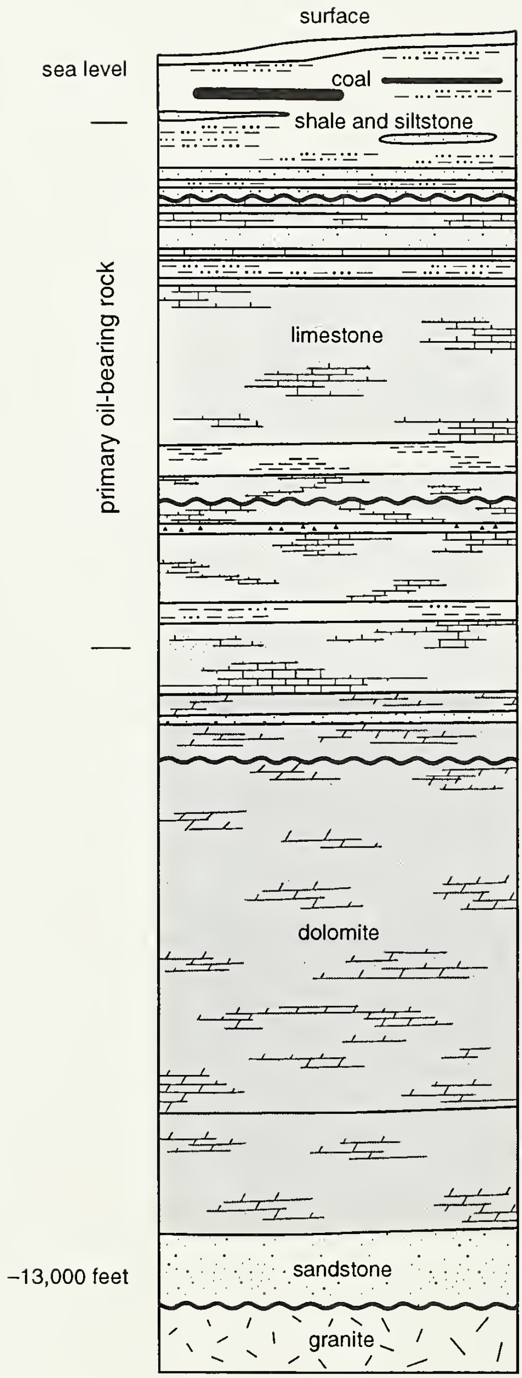
But the glacial cover itself is a great resource, as Shilts reminds us. It's the source of sand and gravel for construction and the groundwater for almost half of our population, the foundation of our towns and roadways, the burial ground for our wastes, and the parent material of the soils for feeding much of the world.

**Tried and true** Before taking the first step to explore or solve any problem involving land and water, you need a geologic map.

### What's a geologic map?

Geologic maps do more than give you a fix on your whereabouts. They show the type of earth materials that lie in different places at and below land surface. So wherever you are, you'll know whether you're standing on sandy or clayey soil materials over a water-yielding pocket of sand and gravel, shaley or limestone bedrock, minable coal seam, porous sand layered on top of one another.

You'll also have a good idea of how thick and deep the layers of earth materials are under your town, county, or the whole region.




Generalized geologic column for southeastern Illinois

If you don't already have a map in hand, you have to make one. Geologists are likely to start the process with air photos or satellite images of the area to plot surface features, then go out and walk the land, scout the subterrain with electrical soundings or seismic (shock) waves, and drill some holes. Back at the GeoSurvey, they'll look in the Records Unit for drill logs of existing wells, study cores of earth materials pulled up during drilling (or found in storage), and finally review, verify, and interpret the data. Last step: construct the map.

Every new search for resources or the best site for a road, bridge, landfill, subdivision, industrial complex or simply a town's new water supply starts with a review of old maps, but ends in the field.

People may map the same places over and over, as in the past, when geologic mapping only targeted specific needs such as protecting groundwater or identifying a resource. Project investigators have concentrated on one rock unit or a short sequence of units, but not on the whole vertical succession of materials. Within the first 50 feet of the surface, they might map the outline of major aquifers, but pay little attention to the materials below.

Later, they're likely to be back covering the same ground, mapping for a waste disposal site, a large hog farm, or any other facility that could have a big impact on the area. Then the focus may be on smaller aquifers and the other earth materials.

**Plotting a new course** The new geologic mapping teams will go to extra lengths, straight down, to get a full succession of earth materials via continuous cores *[see geologic column at left]*.

And they won't stop there. The Illinois GeoSurvey departs from old mapping plans with more than its new multidisciplinary teams, intensive field program, and comprehensive 1:24,000-scale mapping for all 1,071 quads. Now the data collection and map products will be digital.

All available and relevant information will go into easily retrievable data sets in a central database: the computer-based Geographic Information System (GIS) shared by the Illinois Scientific Surveys.

In the long run, the State's geologists will save time and cut costs by mapping all materials once and storing the data in the GIS. Return visits to old sites need only serve the purpose of adding or reinterpreting data according to the latest geological concepts, thus keeping geologic maps up-to-date.

As the database develops, project investigators can retrieve whatever information they need—whenever they need it. From basic digital maps, they can produce "derivative" maps showing resources, geohazards, or an area's suitability for particular uses.

The public is promised full access to all geologic information in the GIS. These valuable maps and data sets, soon to be available, will help with economic development and environmental protection at state and local levels.

**Ecology starts with geology** Protecting ecosystems is a priority for all divisions in the Illinois Department of Natural Resources.

Natural differences in ecosystems begin with climatic gradient, but what primarily controls the ecology of an area is the geology. Look at the landscape of Illinois. Vegetation patterns are attuned to the nature of the underlying earth materials.

The best place to see this is in southern Illinois, where the Shawnee Hills meet the southernmost boundary of continental glaciation in the northern hemisphere. As the land cover map shows dramatically, there's an abrupt break between the grassland ecosystem that developed on glacial soils, and the heavily forested bedrock hills to the south.

*Land cover map, developed from landsat thematic mapper images acquired during spring and fall 1991 to 1995.*

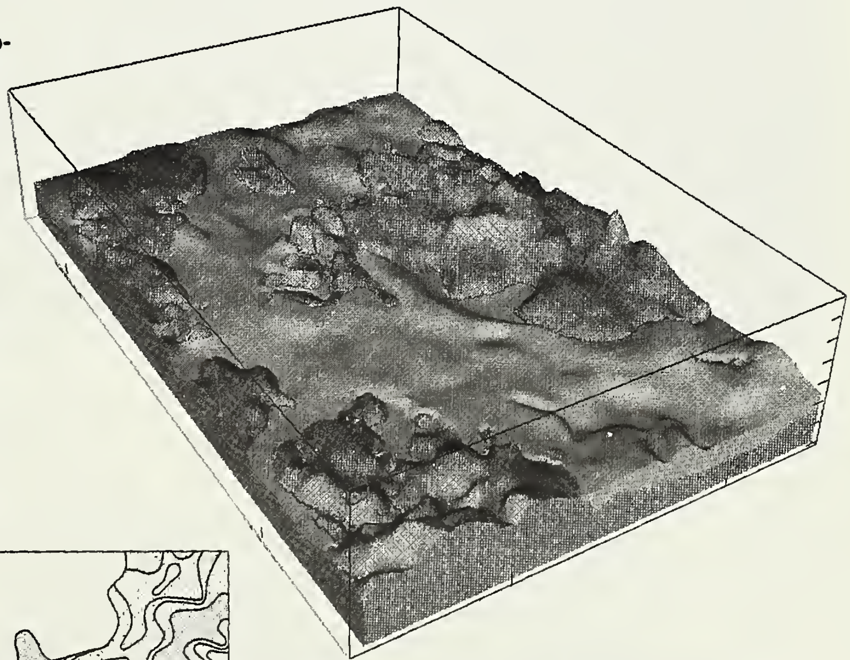
We make sense of what's happened in the past by studying geologic processes in present ecosystems *[see write-ups in the environmental geology section, "Earth is always changing"]*. It's always taken a lively imagination to understand how a three-dimensional ecosystem functions through time. But now we have computer maps and models to help make things clearer.

Here's how geologists put these tools to work. All available new data—water well records, engineering notes, field notes, coal test and other borehole logs, rock material analyses—are interpreted by geologists, then placed into a program such as Earthvision™, which produces a full-color, 3-D view on screen. The geologist can rotate the block structure, slice through it, and strip off layers to examine each or look at what's below. Given this capability, the geologist can refine interpretations and gain insights into the third dimension.

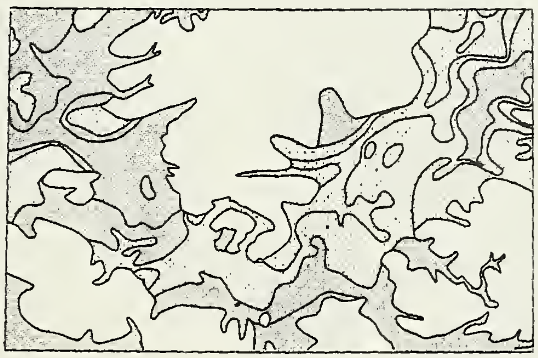
With the right data, a model can be made of the geologic processes in a selected ecosystem, for example, the groundwater flow beneath a floodplain. Should an environmental problem arise, such as a factory discharging pollutants into river sediments, a model could track movement of the contaminant plume through time. Of course, the model would require data from wells and aquifers in the area.

Again with the right data, the model can represent an ecosystem of the past. By studying the placement of surface and subsurface features, and how those features relate to each other, geologists can reconstruct the paleo (ancient) environment. They can tell where a glacier was (in relative time), show that it advanced to some area, deposited materials as it melted back, then overrode those deposits as it advanced again.

Once we can picture what happened in the past, we'll be better prepared to "see" into the future.



*Aquifer materials (Mahomet Sand Member) in the Mahomet Bedrock Valley, underlying east-central Illinois. Three-dimensional maps help us picture shapes and structures below ground surface.*



*Left Two-dimensional map of the Mahomet Sand Member.*

**What'll you have—environmental planning or crisis management?** At a public meeting, somebody jabs a finger at a geologic map of a Chicago suburb. Right here, he says, there's a gas station with a leaking underground tank.

The map shows a valley with peat swamps, and everybody wonders why a large gasoline tank was installed where springs feed a wetland. Apparently, when the place was built, geology wasn't included in the plans.

Most suburban land-*use* planning could *use* some practical facts about geologic conditions—first, on a regional scale, then for specific sites. But towns in the broad belts around cities are expanding fast, paving over the land before anyone has a chance to look beneath the surface. If the geology hasn't been studied before urban/suburban development, it's difficult, disruptive, and dangerous to attempt it afterward.

Decisions about where to put subdivisions, industrial parks, shopping malls, and networks of highways, not to mention well-fields, landfills, and sewers or septic fields, can be as difficult in suburban areas downstate.

The beautiful hillsides of Monroe and Randolph Counties, for example, are filling up with houses, thanks to a rush of residents who spend their work-days across the Mississippi River in St. Louis. They build nice big houses next to sinkholes, install septic systems that discharge into the holes, and soon find their well water undrinkable.

What these newcomers don't realize is that just below the surface of this rolling terrain called "karst" lies limestone full of cracks, caves, and underground streams that supply water to their wells.

Illinois GeoSurvey researchers, working in karst territory for several years, have mapped the rocks and subsurface stream flow *[see write-up, p. 22]*. When they post their karst maps and talk about aquifer contamination at public meetings or county planning-and-development sessions, people take notice. The ecology of this lovely land is so vulnerable, and so is everyone living there.

When people need to know—for their health, safety, and economic well-being—what potential problems lie beneath land surface, geologic mapping is more than helpful. It's necessary.

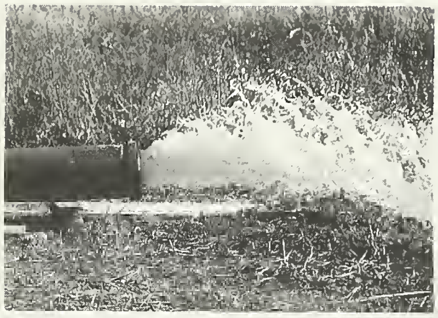

**Urban geology** *Conducting geologic work in urban settings can be a difficult, disruptive, and dangerous undertaking. When probing the earth's subsurface materials, field geologists run the risk of hitting underground utilities—natural gas lines, high-voltage electric lines, water, and telephone fiber optic lines. There's the risk of explosion if they strike a gas line and electrocution if they hit an electric line.*

*Hitting a utility can also be highly disruptive to the public. Drilling into a fiber optic phone line can knock out phone service to a large number of people; breaking a water line can disrupt service to a home or a whole neighborhood.*

*There are other disruptions and dangers. Doing field work in a roadway can be hazardous to the field workers and may impede traffic flow as well. In high-crime areas, geologists and their equipment may need additional protection.*

*Finally, the geology itself is disturbed by urbanization. Subsurface materials are disrupted by building foundations, road construction, and utility installation. Utilities are typically surrounded with permeable sands, which can serve as paths for contaminants to move in directions and into areas where they wouldn't go if normal geologic materials hadn't been disturbed.*

# Maps to the rescue!



**Southwest McLean and southeast Tazewell Counties see an end to water worries** Our maps helped people answer long-standing questions about where to find water and how much to expect *[see write-up, p. 21]*. After getting their maps from a joint Geological and Water Surveys' study, the village of McLean understands why they've had trouble finding water. Companion cross sections show why, when Normal put in their wellfield, water levels fell in neighboring wells. The maps also show how and where the problem could be avoided, if the city develops another wellfield. Both Surveys have talked with local governments, civic groups, and concerned citizens throughout the region. The report, including the maps, has been on the GeoSurvey's best-seller list this year.

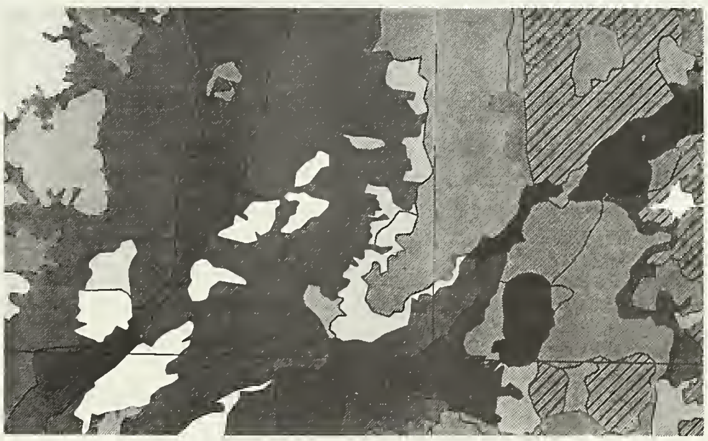
**Strong demand for Illinois GeoSurvey maps in 1995–1996**

- 5,500 printed maps
- 1,300 computer-generated maps turned out on the plotters
- 1,440 blueline copies of maps

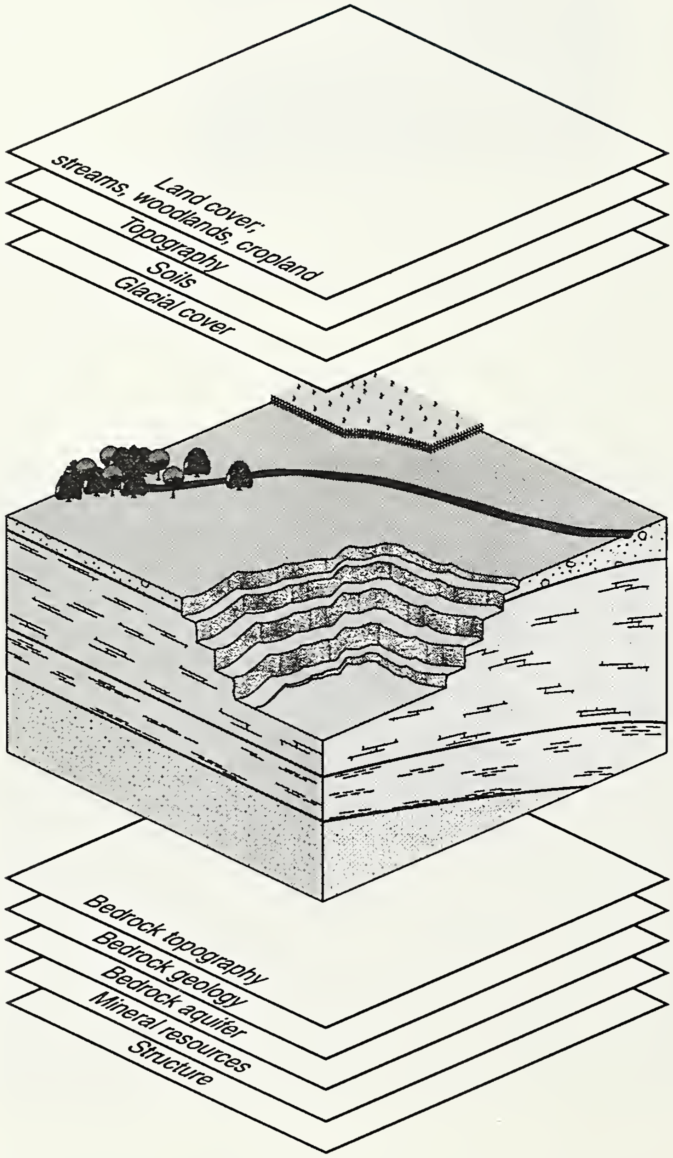
*Plus maps in 12,500 copies of published reports!*

**Shifting sands of Lake Michigan's shoreline** People love lakes; they build marinas, dredge harbors, and do their best to protect the beaches and bluffs from wind and waves. But too much fussing may do more harm than good, say coastal geologists from the GeoSurvey *[see write-ups, p. 18]*. The latest in a long series of maps, starting back in the 1970s, documents sand migration at North Point Marina, Illinois Beach State Park, and Lake Forest Beach. Last year, at 25 meetings with people from local, state, and federal governments, and many community and environmental groups, the maps were the main attraction.

**McHenry County calls time-out** Construction of a crude-oil pipeline, circling from McHenry County through the Chicago metro area, set off public alarms recently. The route-of-choice runs right over thick deposits of sand and gravel less than 50 feet deep. Thanks to new GeoSurvey maps, McHenry County officials realize how susceptible these shallow aquifers are to contamination. Any leak in the pipeline could deliver oil to the ground-water system, then spread it far and wide. Responding to a "911" call from the county health officer, the GeoSurvey shipped a copy of the GIS map, *Potential for Groundwater Contamination, McHenry County*. Our GIS maps, available on demand, give people the information they need—when they need it most.



# Bold strategy "mapped out" in 1995–1996




• ***Keep the public in mind*** Make sure geologic maps get into the right hands. Give people good maps to work with, and they'll look after their drinking-water supplies, locate safe sites for landfills, weigh the risks of building on a floodplain, avoid building near sinkholes, and develop local mineral resources without ruining the neighborhood.

• ***Don't we have all the maps we need?*** Only 5½% of the 56,000 square miles, or 57 of the 1,071 quadrangles, of Illinois have been geologically mapped at the scale of 1:24,000 (1 inch on the map = 2,000 feet on the ground). About 6 quadrangles are mapped each year, so we still have a long way to go.

• ***Strategy: no halfway measures*** Start at land surface and skip nothing! Map a continuous succession of earth materials down to "basement" rock. Bring all earth science data to bear on the project: chemistry, rock properties, mineral composition, structure, surface and groundwater dynamics. Factor in earth hazards, natural and cultivated resources (woodlands, parks, cropland), then overlay with key data on infrastructure (cities, highways).

• ***Team up*** Capitalize on our earth science expertise through multidisciplinary teams *[see team roster below]*.

• ***Advanced digital technology*** Use the GIS (Geographic Information System) to pull together everybody's information on groundwater, rocks and minerals, and vulnerable ecosystems. The GIS gives *control and access* to data in a vast central digital depository, *ease and speed* of compiling layers of information into maps, and *customized maps*. The next step forward takes us to three-dimensional maps and models [see figure].

• ***Mix-and-match maps—on demand*** Create suites of 15 to 20 geologic and related maps, all in the GIS, for each quadrangle and/or county. Keep them up-to-date, ready for assembly in any combination, and delivery to meet the public's needs.

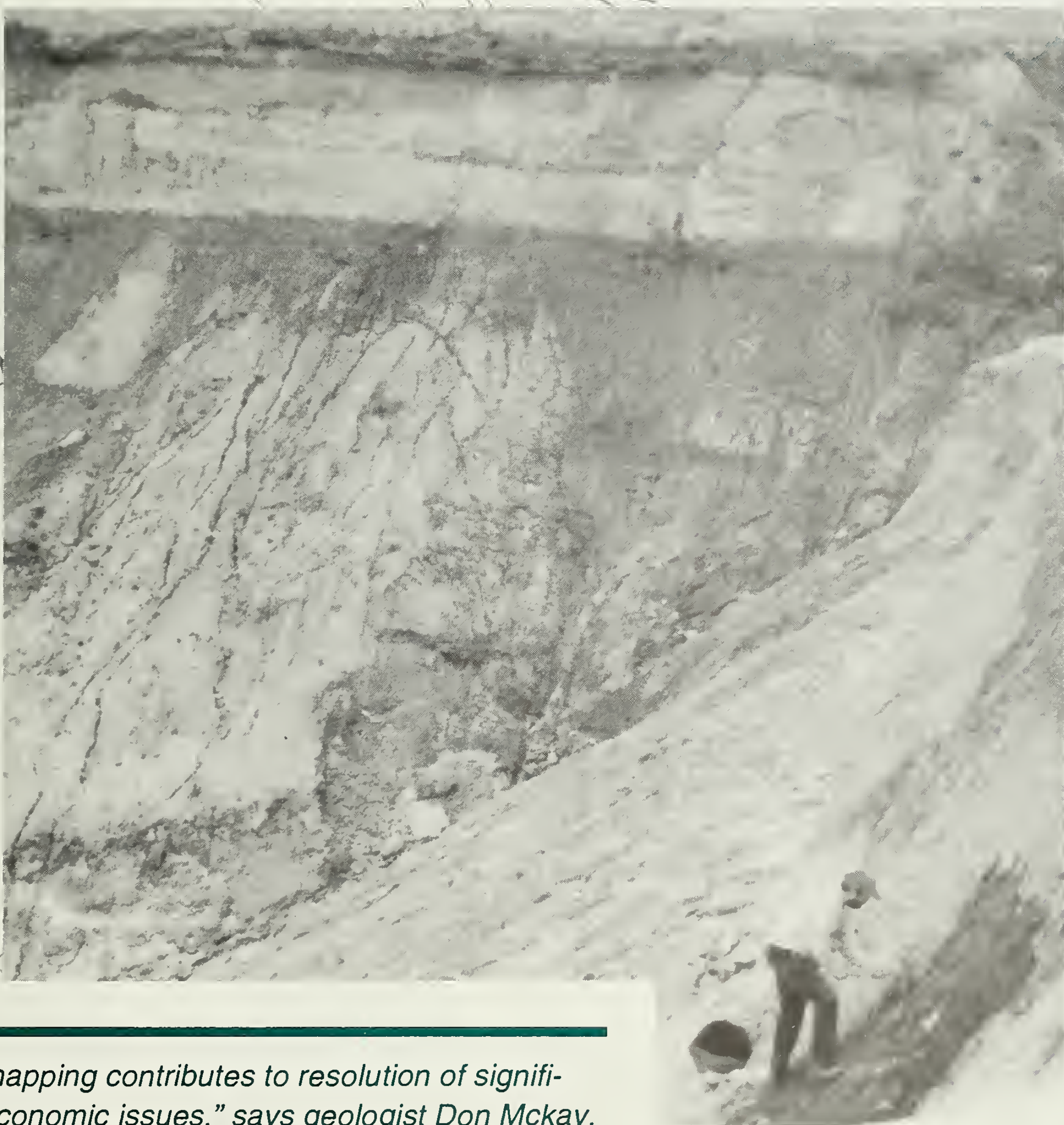
• ***Make it happen*** Two pilot projects, geologic mapping in the Villa Grove and Vincennes quadrangles, started up in 1996 [see p. 8].

**Cross section of GeoSurvey expertise: the mapping implementation team**

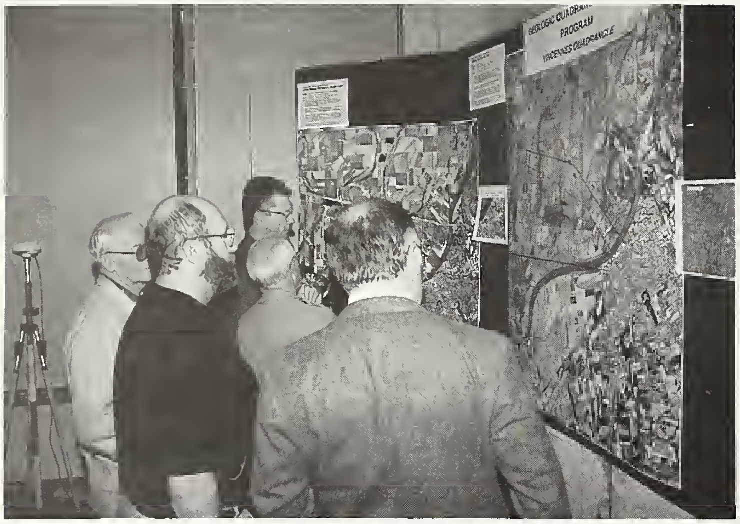
Bob Bauer, engineering geologist
Dick Berg, geologist, team leader
Subhash Bhagwat, mineral economist
Pam Carrillo, cartographic artist
Chen-Lin Chou, geochemist
Dave Larson, groundwater geologist
Don Luman, remote sensing specialist
Leon Follmer, soils geologist
Russ Jacobson, coal geologist
John Nelson, structural geologist
Rob Krumm, geologist, computer specialist
Zak Lasemi, economic geologist
Alison Lecouris, geologist,computer specialist
Don McKay, geologist
Dave Morse, petroleum geologist
Sam Panno, groundwater geochemist
Bill Shilts, glacial geologist, chief

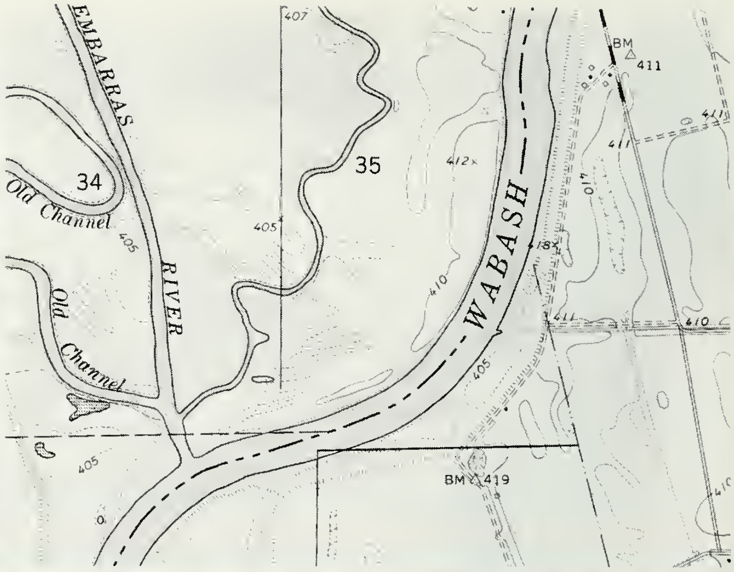
# Knowledge of geology is basic

Wedron Quarry, La Salle County



*"Geologic mapping contributes to resolution of significant socioeconomic issues," says geologist Don Mckay, director of the scientific group creating maps with the computer-based Geographic Information System. He quotes: "The objective of the STATEMAP component of the National Cooperative Geologic Mapping program is to produce maps of the areas in which knowledge of the geology is important to the...welfare of individual states."*






## Ancient arch brings bedrock to surface, Villa Grove quadrangle

*Villa Grove mapping team*

The only place in east-central Illinois where we can look at bedrock in detail is the Villa Grove quadrangle in Douglas County.

"At the Tuscola quarry," says geologist Don Mikulic, leader of this quad's mapping team, "limestone from the Silurian and Devonian ages lies near the surface." Elsewhere, these 340 to 430 million year old rock units are buried under 1,000 feet of younger Mississippian and Pennsylvanian rocks.

There's no better place than a quarry to show how basic geologic mapping and mineral economics go together, according to Zak Lasemi, project co-leader: "The quarry is here because of a small geologic structure called an anticline, which arches upward so it comes within 50 feet of the surface—close enough to mine economically."

That's important. The next nearest sources of high-quality construction stone are Charleston, about 30 miles away, and Fairmont 40 miles away. "Given trucking costs, the price of stone can double for delivery 8 to 24 miles from the quarry," says the GeoSurvey's economist, Subhash Bhagwat. "Fifty miles away the price can be 2 to 3 times higher."

Bedrock mapping of the quadrangle is halfway finished. "Next, we'll drill about 500 feet down from the quarry floor, which is already 250 feet deep," says Mikulic. "That will give us a 750-foot sequence." He adds, "We need to drill deep holes, not just look at bedrock exposed at the surface, to get 3-D views of the rock units."

The glacial cover, 100 to 200 feet deep in some places, is getting close attention from geologists Dick Berg and Ardith Hansel. The GeoSurvey will use its own equipment to drill and collect cores from several holes about 50 feet deep in the Quaternary ("Ice Age") deposits.

"Our mapping will tell people where the shallow aquifers are," says Berg, "which would be a big help both in drilling for water and protecting it."

Flooding along the Embarras River is a perennial issue in Villa Grove. The Water Survey will help out with a map showing flooding potential along the Embarras.

If all goes according to plan, the data gathering and drilling will be completed in 1996–1997.

## Vincennes quadrangle straddling the Illinois–Indiana state line

*Vincennes mapping team*

The Wabash River splits the Vincennes quadrangle between Lawrence County in Illinois and Knox County in Indiana.

Woven across the low-lying quad are layers of river sediments, the earliest dating from the "Ice Age."

The complex soils interest geologists from both sides of the border, says Illinois geologist Dave Morse, mapping team leader. But what do people living in the quad hope to learn about their land?

The Illinois and Indiana Geological Surveys, which are pooling resources for the mapping, held public meetings at Indiana's Vincennes University this fall. City planners and engineers, water well drillers, oil consultants, and local farmers got the opportunity to speak up.

One supplier of construction materials showed an interest in gravel deposits, which might serve a growing local market.

A woman whose family works a good-sized farm wondered, "Why is the soil in this quadrangle so sandy that water drains right through it? Just north of the boundary, the soil is dark and rich."

A well driller picked up the topic of groundwater resources, while someone else worried about possible sources of contamination for both surface and groundwater.

Oil potential drew a few questions. Back in 1940, one man recalled, oil gushed out of wells.

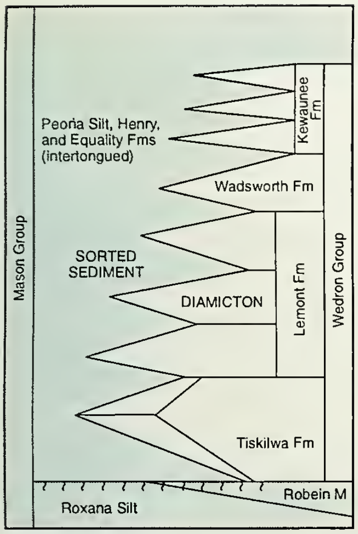
Geologic mapping will focus on all the above and more.

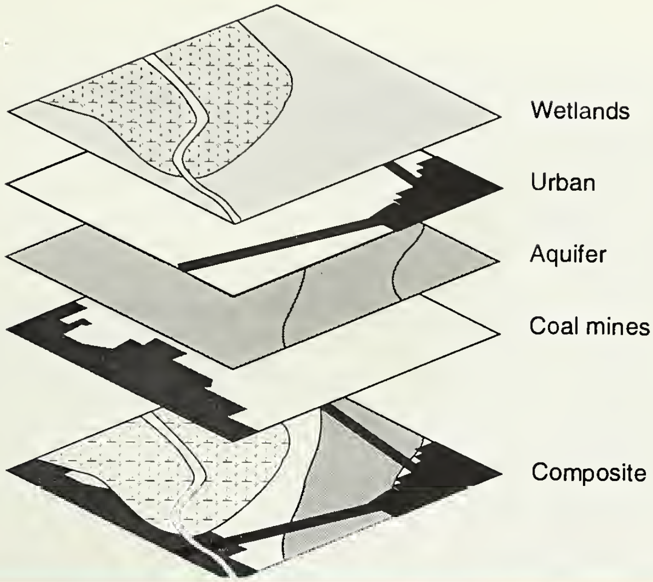
Where the Embarras and Wabash Rivers join, "we'll look at the thickness, strength, and other properties of sediments," says engineering geologist Bob Bauer from the Illinois GeoSurvey, "so we can predict how these materials will behave during an earthquake." Maps assigning risk values to different types of earth materials are standard for land-use planning in this part of the state.

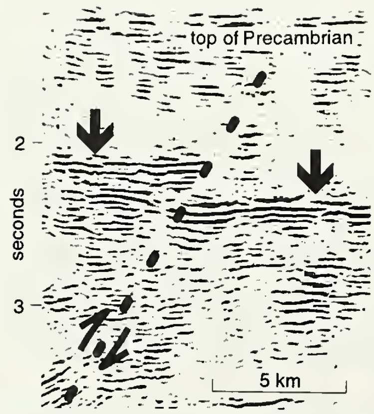
Aiming for a continuous vertical sequence of materials, as in the Villa Grove quadrangle, the team plans to drill a deep hole several hundred feet down into bedrock.

Shallower borings into the sediments overlying bedrock will add to the data on groundwater, rock and mineral resources, and environmental hazards.

During 1996–1997, the Vincennes team expects to collect and analyze their data, then tuck it all into the GIS (Geographic Information System). Next step is to construct three-dimensional maps and models.




## Reclassification of the State's glacial cover

*Ardith Hansel*
*Hilton Johnson*

People who need to make wise decisions about the state's land and water resources will find the GeoSurvey's new classification of glacial deposits a useful reference.

Earth materials of the last glacial episode are the basic component of the state's landscape. They cover most of Illinois and average nearly 100 feet thick.

Hansel and Johnson's reclassification is based on material differences between units. These differences are related to the different episodes of erosion and deposition produced by repeated cycles of glacier advances and retreats.

The classification improves our understanding of glacial history. Such understanding helps engineers, environmental consultants, and planners predict, for example, the size of a sand and gravel unit found in a landfill or water test hole.

*Wedron and Mason Groups: Lithostratigraphic Reclassification of Deposits of the Wisconsin Episode, Lake Michigan Lobe Area*, ISGS Bulletin 104, 1996

## State screening for low-level radioactive waste sites

*Keros Cartwright*
*Don McKay*
*Computer mapping team**

Science, not politics, is guiding the search for the right resting place for the low-level radioactive wastes produced by commerce and industry in Illinois.

In 1993, the Illinois Legislature told the State Geological and Water Surveys to screen the state for ten locations likely to contain a suitable site.

It's a big mapping project—just right for the computer-based Geographic Information System. The GIS is the means to pull together everything the Surveys have on minerals, groundwater, and vulnerable environments.

Valuable data are also being contributed by the Illinois Environmental Protection Agency, State Natural History Survey, and U.S. Geological Survey.

GIS maps of what's below ground (such as water and mineral resources) are ready to combine with coverages of surface features (such as streams and nature preserves). Each database has been updated, and each map rigorously documented for source, content, and accuracy.

** Krumm (leader), Abert, Nelson, Riggs, Jahn, Weibel, and Rice*

Maps available in spring 1997

## Mapping supports county landfill screening

*Matt Riggs*
*Rob Krumm*
*Chris McGarry*

County governments, trying to site landfills, can count on the State GeoSurvey to supply much-needed geographic and geologic information.

Last March, the Survey's Geospatial Analysis team held a workshop to show representatives from nine counties and a regional planning commission what mapping can do for them.

The regional geology, mapped in broad detail, is what the GeoSurvey offers local governments—before they invest time and tax dollars in evaluating specific sites. The advantage of tapping into the statewide database is that they eliminate many unsuitable areas at the outset of the waste facility siting process.

Maps of parts of Lake and Will Counties, and a nearly complete map set for McLean County have been produced for the project. Mapping is now focused on Carroll and Lee Counties.

*Southern Will County* maps, Open File Series 1993 9a–9m, and *North-Central Lake County* maps, Open File Series 1993 10a–10k

## Better safe than sorry: earthquake research in the Wabash Valley

*John McBride*
*Mike Sargent*
*Computer mapping team**

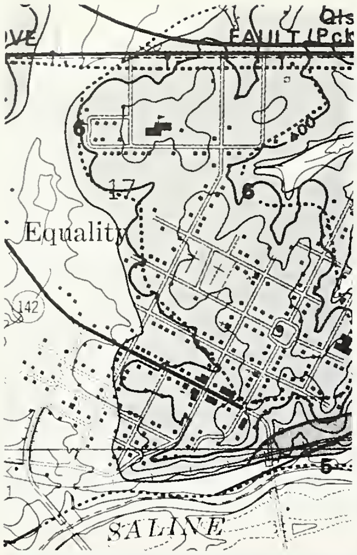
A 5.5-magnitude earthquake shook the countryside around Broughton in Hamilton County back in 1968. Could it have reactivated ancient faults deep in "basement" rocks?

The possibility intrigues Survey geophysicists studying a seismic reflection profile taken over the Wabash Valley Seismic Zone near the earthquake's epicenter. The profile, a visual record of shock waves bounced (reflected) back from rocks, reveals a zone in the crystalline basement rocks that may be "blind" (hidden) thrust faults.

When mapping zones of weakness that may control earthquakes in the region, geophysicists have solid support. The U.S. Geological Survey is working with the Illinois, Indiana, and Kentucky Surveys on a map atlas of the Wabash Valley Seismic Zone, roughly 19,000 square miles of the three states.

The Illinois GeoSurvey is compiling maps of earth materials and, for emergency management, locations of roads, bridges, pipelines, power lines, schools, and hospitals.

** Krumm, Hester, Stiff, Smith, Bauer, and Su*




## What you can't see, the reason for geologic mapping

*John Nelson*
*Brandon Curry*
*Ardith Hansel*

Charting soil and rocks a few feet to thousands of feet deep isn't easy. Fortunately, the State's geologists are not really working "blind."

Their experience is backed by a vast database of well and borehole records, rock cores and samples, and the maps and reports of their predecessors in the field. The GeoSurvey has been in the mapping business since 1906.

New maps of the year!

*Quaternary Geology of the Geneva and Elburn 7.5-Minute Quadrangles* (scale 1:24,000), Open File Map, 1995: B. Curry, A. Hansel, B. Stiff, D. Grimley

*Geologic Map of the Bloomfield Quadrangle, Johnson County* (scale 1:24,000), ISGS IGQ-10, 1995: W.J. Nelson

*Geologic Map of the Jonesboro and Ware Quadrangles* (scale 1:24,000), ISGS IGQ-14, 1995: W.J. Nelson, J. Devera

*Geologic Map of the Mill Creek and McClure Quadrangles* (scale 1:24,000), ISGS IGQ- 15, 1995: W.J. Nelson, J. Devera, J. Masters

*Geologic Map of the Cobden Quadrangle* (scale 1:24,000), ISGS IGQ-16, 1995: W.J. Nelson, J. Devera

## Shaded Relief Map of Illinois

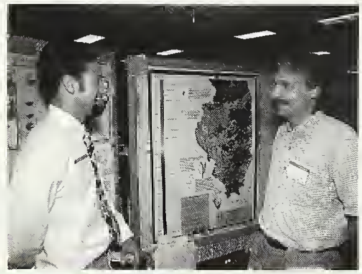
*Curt Abert*

The "highs" and "lows" of the land surface form its topography. The differences in elevation are known as relief.

A shaded relief map shows landforms by simulating the appearance of light and shadows. The perspective is like the view from an overhead satellite at sunset, when shadows and light emphasize the natural shapes and patterns of the landscape: the valleys of the major rivers, and their nearly flat floodplains and steep valley walls; the tributaries of the major rivers, particularly the branchlike (dendritic) drainageways in the south-central part of the state; the hilly, sharply dissected topography of the unglaciated areas in the northwestern and southern parts of the state; and the subdued arc-shaped ridges (moraines) interspersed with flat areas in the northeastern quadrant of the state.

Originally on open file, the map has been printed to meet the high demand for it.

*Shaded Relief Map of Illinois* (scale 1:500,000), ISGS Illinois Map 6



## GeoSurvey host to Arc/Info users at midwest conference

*Rob Krumm*
*Computer mapping team**

Arc/Info is the software that Illinois' Scientific Surveys use to run their computer-based Geographic Information System (GIS), which holds all digitized data they have on the State's natural resources.

It's also the software of choice for 330 people who packed the Midwest/Great Lakes Arc/Info User Conference, hosted by the Illinois GeoSurvey in Champaign in 1995. People from government, academia, and business in 12 states came to learn new tricks of the trade.

Highlights included "keynotes" by John Bossler, one of the world's leading experts on the GIS, a talk on GIS policy by Illinois Representative Tom Ryder, and a workshop that drew 95 people—all interested in ArcView, the new user-friendly way to access, query, and display Arc/Info maps.

GeoSurvey staff led sessions, handled logistics, gave talks, and displayed their maps.

Hosting a conference is hard work. It's also an honor.

** Abert, Nelson, McGarry, Hines, Smith, Riggs, Denhart, and Rice*

## Geological field trips grow in popularity

*Wayne Frankie*
*Russ Jacobson*

Would you believe hundreds of Illinoisans spend their weekends looking at rocks and quarries?

Loyal regulars keep coming back to our fall and spring field trips, and newcomers also delight at the chance to get acquainted with the geology, landscape, and mineral resources of Illinois. Attendance at the four field trips this 1995–96 season rose to 1,075, nearly double the previous year's count of 587 field trippers.

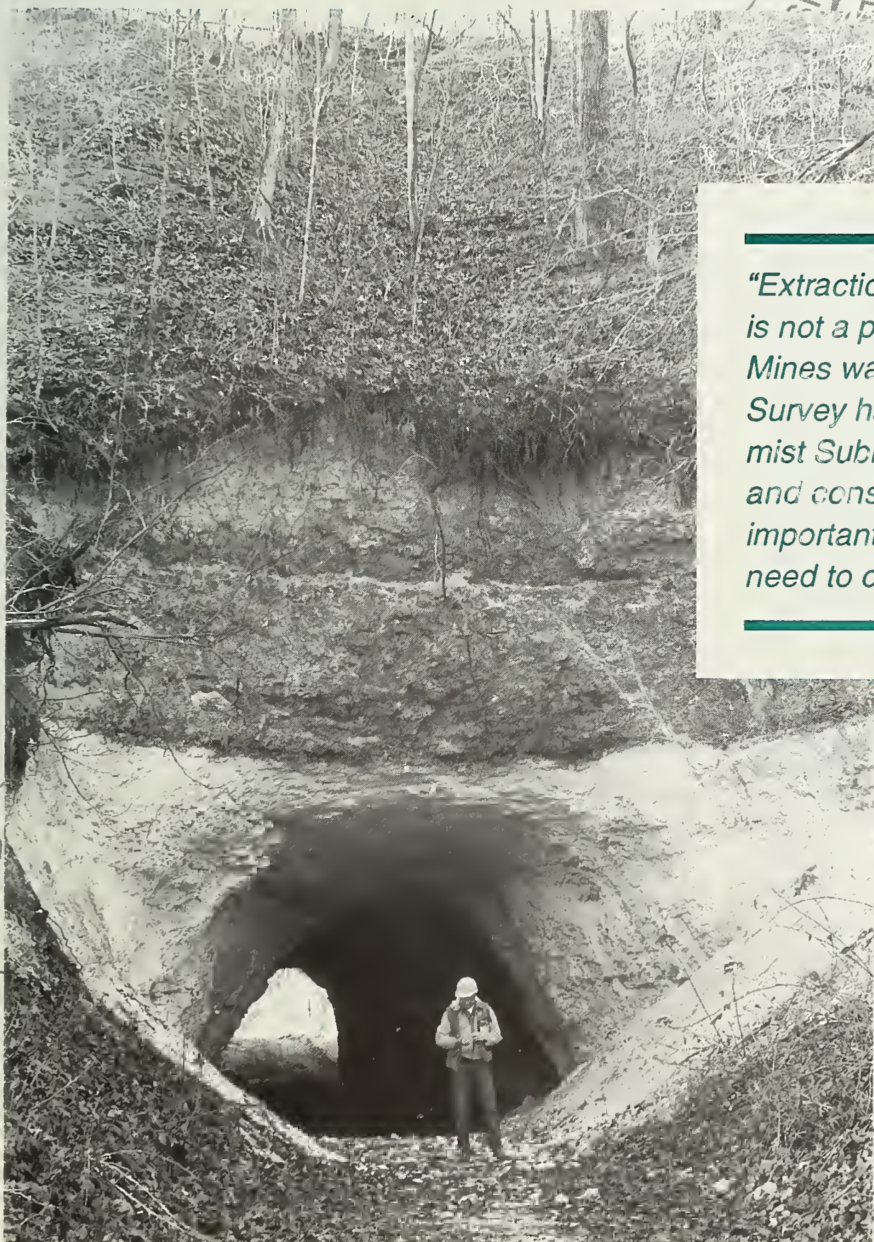
This season teachers and students abandoned the classroom for special Friday school day field trips in the Pontiac-Streator and Hoopeston areas. The students collected fossil, rock, and mineral specimens, and heard firsthand from the experts about how geologic processes shaped the landscape around them.

Join us for our two free field trips in spring 1997: April 19, at the cavern region near Columbia and Waterloo in St. Clair and Monroe Counties; and May 17, at Buffalo Rock and Matthiessen State Parks in La Salle County.

*Geological Science Field Trips*, ISGS brochure, 1996

# In field and lab, minerals research backs discovery with recovery

Inactive silica mine, Alexander County



*"Extraction and utilization of mineral resources is not a priority nationwide. The U.S. Bureau of Mines was abolished, and the U.S. Geological Survey has changed direction," mineral economist Subhash Bhagwat says. "But the coal, oil, and construction stone industries are very important to local economies. That's why we need to continue our resource-related geology."*



## Flatter than a pancake, resource-rich Galena and Platteville rocks

*Dennis Kolata*

In northern Illinois, 350-foot thicknesses of limestone and dolomite, named the Platteville and Galena by Illinois geologists, are a good source of construction stone and groundwater. The same strata (rock layers) in southern Illinois yield small to moderate amounts of petroleum.

Spread over the midcontinent, these fairly flat, uniform strata tell geologists what the world was like more than 450 million years ago: the middle of this continent was a warm, shallow sea teeming with marine organisms. Their shells, skeletons, and other debris accumulated on the sea floor, and later formed the bulk of the rock. Erupting volcanoes also spread thin layers of ash, which are now "marker" beds that help geologists recognize these formations elsewhere in eastern North America.

Once you know the "environment of deposition," as geologists call it, you'll have a good idea where to explore for oil, construction stone, and groundwater.

*Ordovician K-Bentonites of Eastern North America*, Geological Society of America Special Paper 313, 1996: Kolata, Huff, Bergström

## Fossil sea critters, conodonts, in quarry stone

*Rod Norby*
*Don Mikulic*

All construction that uses concrete needs aggregate—stone crushed into different sizes. An ideal source, the dolomite dating back to the Silurian age 405 to 435 years ago, lies no more than 10 or 20 feet below the surface in parts of northeastern Illinois.

People looking at this dolomite have trouble spotting differences in rock, not just between layers but laterally—or sideways. That's where conodonts come in.

Conodont fossils look a bit like fish teeth, although you need a microscope to make out the details. Studying them helps geologists date the rocks they're found in. Because conodonts evolved fast (geologically speaking), each distinctive species pinpoints an interval of time.

Slight variations in fossils from place to place also make it easier to identify differences in bodies of rock across a region.

Only the State GeoSurvey studies regional variations and trends in rock. But the information is available to everyone. Without it, producers of construction aggregate might have a hard time finding high-quality stone reserves.

## More than one way to slice the rock—limestone cycles

*Zak Lasemi*
*Rod Norby*
*Subhash Bhagwat*

Predicting where and how much high-quality rock lies in unmined areas, such as the bottom of a quarry, calls for ingenuity.

Identifying rock layers or levels by dating with conodont fossils may be too broad in scale. Conodonts differ based on how many thousands to millions of years it took the species to evolve. Some regions need tighter focus on a body of rock.

Case in point: the GeoSurvey recently used "cycles" in a rock formation to locate high-calcium limestone in a western Illinois quarry.

Regional studies of the Salem Limestone Formation, the stone in the quarry, show five cycles that represent a repeated pattern of sedimentation. Ages ago in the environment of deposition, the same sequence (each cycle) of sediments was laid down five times.

Geologists used the information to predict—successfully—that minable rock lay under the quarry floor.

The highly marketable, high-calcium limestone is used to neutralize acid drainage from mines and toxic emissions in flue-gas of coal-burning plants.

## Without crushed stone, we can't build much of anything

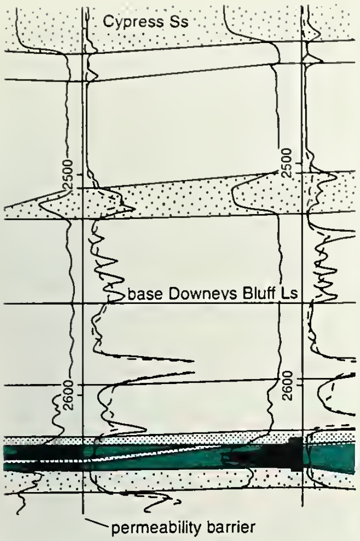
*Don Mikulic*
*Zak Lasemi*
*Subhash Bhagwat*

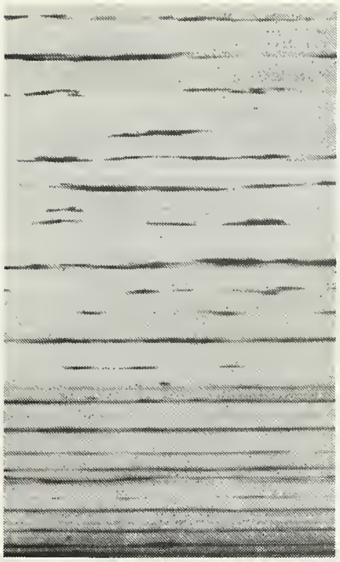
$120 million worth of construction aggregate is sold each year in the Chicago area. That's 30 million tons of stone, almost half of Illinois' yearly output of rock products.

Many quarries, like McCook and Thornton serving the metro market, have their own geologists but still call on the Illinois GeoSurvey to help interpret regional trends and calculate the market impact of available reserves. Only the GeoSurvey offers the regional overview, showing quarry owners which way high-quality rock trends and saving more than one operation from mining substandard stone.

Downstate quarries, like the North Central Material Company in Kankakee County and the Tuscola Stone Company in Douglas County, also benefit from the GeoSurvey's unique expertise.

In return for the State's investment, the State's economy reaps the rewards of an industry with a $500 million turnover per year.




## Pressure data pay off for Zeigler Field oil production

*Beverly Seyler*

What drives oil out of porous Aux Vases Sandstone is the pressure it's under. Given pressure data, oil field operators can tell a lot about a reservoir: its size, how oil-saturated it is, and where permeability barriers obstruct the flow of fluid.

Pressure starts depleting with production from the first well. Unless something is done, the pressure fizzles out and leaves oil behind.

Zeigler Field operators, steadily monitoring pressure as they developed the reservoir, learned when and where the permeability was blocked. By strategically converting producing wells to water injection, they kept up the pressure—and production.

Recovery efficiency was 45–50% in Zeigler, a high for the Illinois Basin. Seyler's thorough study shows the value of combining good geology with basic engineering to improve oil recovery.

*Reservoir Characterization for Effective Management: Zeigler Field, Franklin County*, ISGS Illinois Petroleum series, in press

## Chemical clues in the search for oil-rich rock

*Joyce Frost*

Chemical analyses of nearly 400 samples of organic-rich shale formed in the Illinois Basin about 408 to 320 million years ago reveal much about the environment at that time.

The samples were analyzed for organic carbon, total and pyritic sulfur, and iron content. By studying the relationships between these components of rocks, Frost confirmed that the muds and other sediments that eventually formed into shale were deposited slowly, under deep marine conditions in the basin. There was little or no oxygen in the water. Bacteria fed on the organic matter in the sediments and produced hydrogen sulfide from seawater sulfate.

Reconstructing depositional environments from chemical and other data helps in the search for "source rock," that is, new sources of oil in the New Albany Shale.

*Geochemistry of Black Shales of the New Albany Group (Devonian–Mississippian) in the Illinois Basin: Relationships between Lithofacies and the Carbon, Sulfur, and Iron Contents,* ISGS Circular 557, 1996

## New Albany Shale, main source of Illinois' oil reserves

*David Morse*

Oil, a multibillion-dollar resource of Illinois, is still being found deep in the strata of the Illinois Basin. It formed by natural heating of the organic-rich black shale known as the New Albany.

Joint research by the Illinois and U.S. Geological Surveys has found, by analyzing drilling cores and cuttings, where the shale reached a temperature hot enough to create oil.

Oil migrates to porous sandstone or limestone reservoirs called "traps," where it stays until tapped by the oilman's drill bit. It's a risky venture that often ends in dry holes. But the risks may be reduced, as oilmen discovered in the 1940s and 1950s, by drilling where the oil formed in southeast Illinois.

The next challenge is figuring out exactly how and where this migrating oil got trapped in central and western Illinois.

PTTC
Petroleum Technology Transfer Council

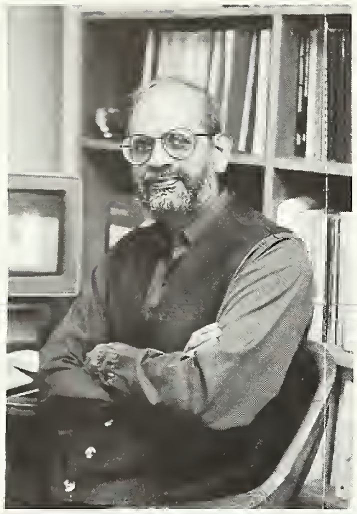
## New technology for oil and gas industry

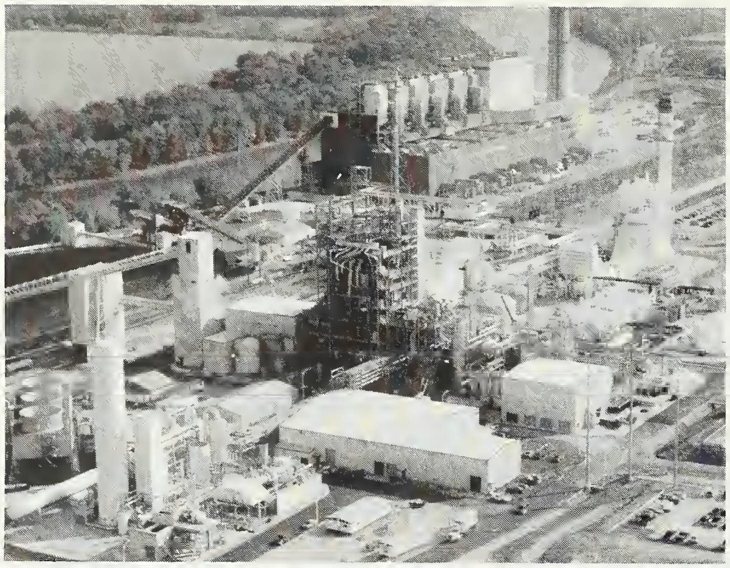
*Tom Davis*
*David Morse*

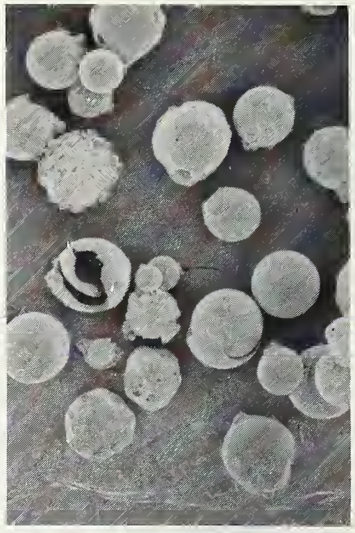
Oil and gas producers in the Midwest need look no farther than the Illinois GeoSurvey for new technology—like 3-D seismic for probing subsurface earth materials and horizontal drilling—to help them discover oil and improve its recovery from the ground.

Recognized for its history of working with oil and gas producers and providing them technological expertise, the Survey is now the Midwest regional office for the Petroleum Technology Transfer Council (PTTC), a national clearinghouse for the technical information that U.S. operators need to produce more oil and gas economically.

The Midwest office, serving Illinois, Indiana, Michigan, and western Kentucky, has developed a Web page and hosted workshops on horizontal drilling and 3-D seismic. An improved oil and gas database and more technology workshops are forthcoming.







## Economic analysis steers minerals engineering research

*Subhash Bhagwat*

Full speed ahead or hit the brakes? The GeoSurvey's economist analysed three coal-related projects last year.

- "Activated" carbons from Illinois coal can remove impurities from incinerator flue gas. Pricing the carbon at $330 per ton would cover costs of production yet bring a reasonable return.

  Commercial activated carbon costs about $2,000 per ton. This research gets the go-ahead.

- Converting paint sludge to filters for auto emissions was tackled by the GeoSurvey working with Ford researchers. Mix sludge with coal, then char and activate it for super-adsorbency, all in one step. Would it pay off?

  Maybe not. Estimates put the cost of production at about $500 per ton. That's higher than the cost of a purely coal-based filter.

- Mats of activated carbon fiber made from polymers are used to catch volatile organic compounds (VOCs) from waste gases of industrial processes. VOCs, acetone for example, can be recovered and the mat reused, at a cost of 90¢ to $1.75 per kilogram of acetone recovered. Acetone sells for $5.40 per kilogram, so developing coal-based fibers to replace polymer-based fibers could be profitable.

## Convert coal into gas, high hopes for high-sulfur coal

*Tony Lizzio*
*Mark Cal*

Convert coal into gas, then you can burn it cleanly, efficiently.

The process has a fancy name: integrated gasification-combined cycle, or IGCC.

It also has a fancy price. An IGCC power plant is pretty expensive to build and operate. Construction and fuel costs both have to come down to attract investors. The U.S. Department of Energy subsidizes several IGCC plants, including one working with the GeoSurvey.

High-sulfur Illinois coals, perfect for IGCC, are being tested in the Minerals Engineering Lab to find out which ones work best in this process.

The next step is to develop methods to remove sulfur from the coal-turned-into-gas without cooling it. Cooling down the gas cuts down on process efficiency.

Activated carbons, also being developed in GeoSurvey labs *[see next project]*, can remove sulfur from high-temperature coal gas. The sulfur is easily turned into marketable products.

## Supercarbons capture $SO_2$ and $NO_x$ in flue gas from power plants

*Tony Lizzio*
*Mark Cal*

The acid gases sulfur dioxide and nitrogen oxide are removed from flue gas by filters made with activated carbon. "Activated" means the carbon has been treated to enlarge its pores on a microscopic level. So each carbon particle has more surface area, and more area means more sites to adsorb (attract and hold) gas molecules.

The adsorption capacities of some activated carbons developed by GeoSurvey researchers are greater than those of commercial carbons. They also work at a range of temperatures.

These carbons are now being tested as the primary adsorbent in a process that has reached commercial demonstration. If successful, the GeoSurvey's process will remove acid gases more economically than conventional processes using limestone. The bonus is—no solid waste.

## Good uses for coal fly ash

*Joe DeBarr*
*Dave Rapp*

Right now, less than 25% of the fly ash from burning coal is made into useful products. The rest is discarded at a cost to the company, and of course, to the consumer.

At the GeoSurvey's Applied Research Lab, work funded by the Illinois Clean Coal Institute shows that fly ash can be turned to good use as a construction material or additive in cement, bricks, pipes, mine supports, brakes, and ceramics.

Fly ash is not just a filler. When used in cement, it reacts with other ingredients to form a durable product that's also easy to handle.

Highly marketable carbon, magnetite, and cenospheres (hollow spherical particles used in lightweight materials) have also been separated from bulk fly ash. All methods used in the research are industrially feasible now.

## Recycling coal ash a money-saving option for coal producers

*Gary Dreher*
*William Roy*
*John Steele*

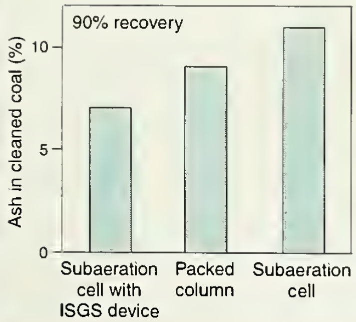
The mounds of coal ash piling up at some of Illinois' high-sulfur coal mines may actually have something useful to offer—a solution to a related problem— the acid-producing waste retained separately in a slurry pond.

A byproduct of coal cleaning, this waste is potentially an acid contaminant and must be covered with soil. The ash, produced by a coal burning process called fluidized-bed combustion (FBC), is alkaline.

Chemists at the Illinois GeoSurvey have developed a reclamation method that relies on the alkaline nature of the FBC ash to buffer acid production by the slurry waste. The method has already been tested in the laboratory with promising results. A field demonstration is now in the works to "codispose" of FBC ash with coal slurry waste at a mine in west-central Illinois.

If the reclamation technique is successful and the regulatory authorities accept it, it could alleviate the need for soil cover, which now costs the industry up to $10,000 per acre.

*Laboratory Studies on the Codisposal of Fluidized-Bed Combustion Residue and Coal Slurry Solid*, ISGS Environmental Geology 150,1996




## Squeaky clean coal from new froth flotation device

*Latif Khan*
*John Lytle*

Before it goes to market, most coal from Illinois is "cleaned" of its mineral matter, including some sulfur. One cleaning method, froth flotation, lifts and floats "dirt" away.

It's like running coal through the washer, only call it a subaeration cell. A rotor pulls in air, creating bubbles in the water. With a surfactant to stabilize the bubbles, you get froth. The air bubbles collide with coal particles, then lift and float them off. But mineral particles, with their affinity for water, get left behind.

In GeoSurvey labs, engineers are testing a new device they invented to work with a subaeration cell. They no longer need three or four cells; they get the same results with one. Cleaning capacity and efficiency increase greatly.

Now Illinois coal producers can look forward to cleaner bulk coal *plus* recovery of coal fines now lost to slurry ponds. Around the world, the new froth flotation will improve separation of other valuable minerals, not just coal, from undesirable wastes.

The potential for the GeoSurvey's device (patent likely) has not been lost on commercial producers of flotation machines. Stay tuned for developments.

## The case of the disappearing algae and low(er) sulfur coal

*Russ Peppers*
*Dick Harvey*

About 315 million years ago, the blue-green alga, *Botryococcus*, disappeared from Illinois Basin coals.

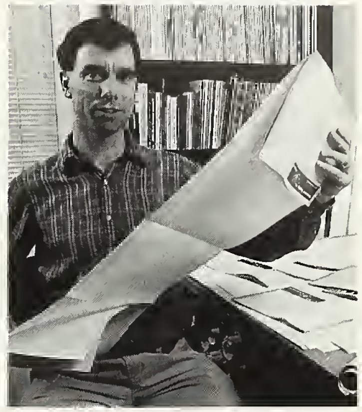
Fossils of the organism keep turning up all over the basin, from northwestern Illinois to western Kentucky, but only in early Pennsylvanian coal beds (11 at last tally).

Restricted to little bands in the coal, these well-preserved algal colonies show little or no compaction, even though once buried under rocks 1 mile thick.

The species is still around today, unchanged in 400 million years. Why don't we see evidence of them from mid-Pennsylvanian to modern times? It's a mystery.

The fossils are clues to another mystery: where to find more deposits of low-sulfur coal. Because *Botryococcus* grows in fresh to brackish water, the environment of coal deposition must have been the same back in Pennsylvanian times.

Wherever seawater covered the great deposits of decomposing plant matter (the stuff that coal is made of), we're more likely to find high-sulfur coal. To find lower sulfur coal, look for fresh-water sediments above the coal beds.



## Plenty of coal— Can we get to it? Can we afford it?

*Colin Treworgy*

Coal miners have known for years that not all of what's called "reserves" is minable.

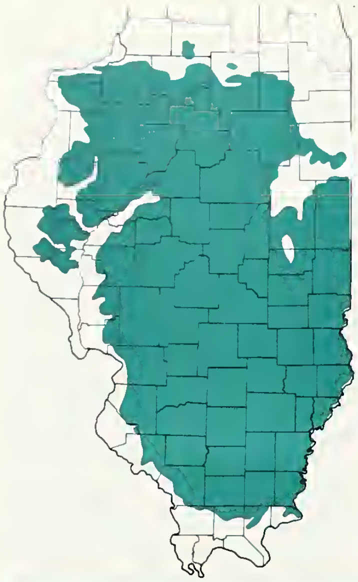
How much coal is actually available for development? To find out, the U.S. Geological Survey is supporting studies in states with major coal deposits.

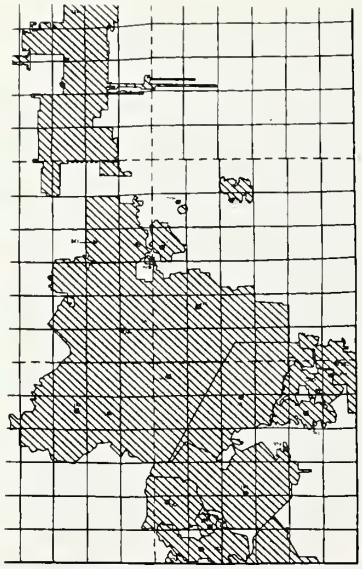
Off limits are coal seams under cities, highways, railroads, active oil fields, cemeteries, and sensitive environments such as floodplains. This cuts only 5–10% from the tally of available reserves.

Geologic and engineering factors are bigger restrictions.
(1) Bedrock lying over a coal seam may not be thick and strong enough to hold up all other earth materials between the mine and land surface.
(2) Two coal seams may be too close to mine both without the rock collapsing between them.
(3) Rock in the seam may get in the way of mining coal.

The GeoSurvey's current goal is to categorize the state's remaining resource estimates by cost of mining: how much coal can be mined at $10 to $25 per ton, or more.

*Illinois Coal Reserve Assessment: Part 1*, ISGS Open File Series 1995-11





## 1970s coal "boom" turns into coal-data "boon" for the State

*Colin Treworgy*
*Heinz Damberger*

Tens of millions of exploration dollars were spent in Illinois by companies expecting to use coal to cash in on the energy crisis of the 1970s. They drilled holes, analyzed samples, and experimented with turning coal into gas.

Low oil, gas, and coal prices put all plans on hold. Recently, several major companies were persuaded to put their data into the public domain.

These data on depth, thickness, heating value, and quality (ash, moisture, and sulfur content) of the resource in places previously unexplored now enrich the Illinois GeoSurvey's database.

Who uses coal data?

- Catlin Coal, a small but enterprising company, started producing fairly low-sulfur coal from a new mine in Vermilion County in spring 1996. The key information for planning and development came from the GeoSurvey.
- A landowners' association in Douglas County is trying to attract interest to a low-sulfur deposit in their area. Drill-hole data, analyzed by the Survey's coal experts, is part of their prospectus.

## Is there a coal mine under my land?

*Jennifer Hines*
*Bob Bauer*
*Heinz Damberger*

Hundreds of calls about undermined land come in to the Illinois GeoSurvey each year. Homeowners want to know whether they need subsidence insurance; banks and real estate firms need to consider potential liabilities; engineers and builders seek information before getting deep into planning and development. Some people are interested in whether a structure might be damaged by mine subsidence.

The reason for their worries: 16% of residential land in Illinois lies right over or next to an underground mine.

Both surface and underground mines are outlined on 80 county maps maintained at the Illinois GeoSurvey. The latest revision updates the set to January 1996.

People can buy copies of each county map, complete with a directory giving mine names and owners, years of operation, and a few other facts. For more information, call 217-333-ISGS.

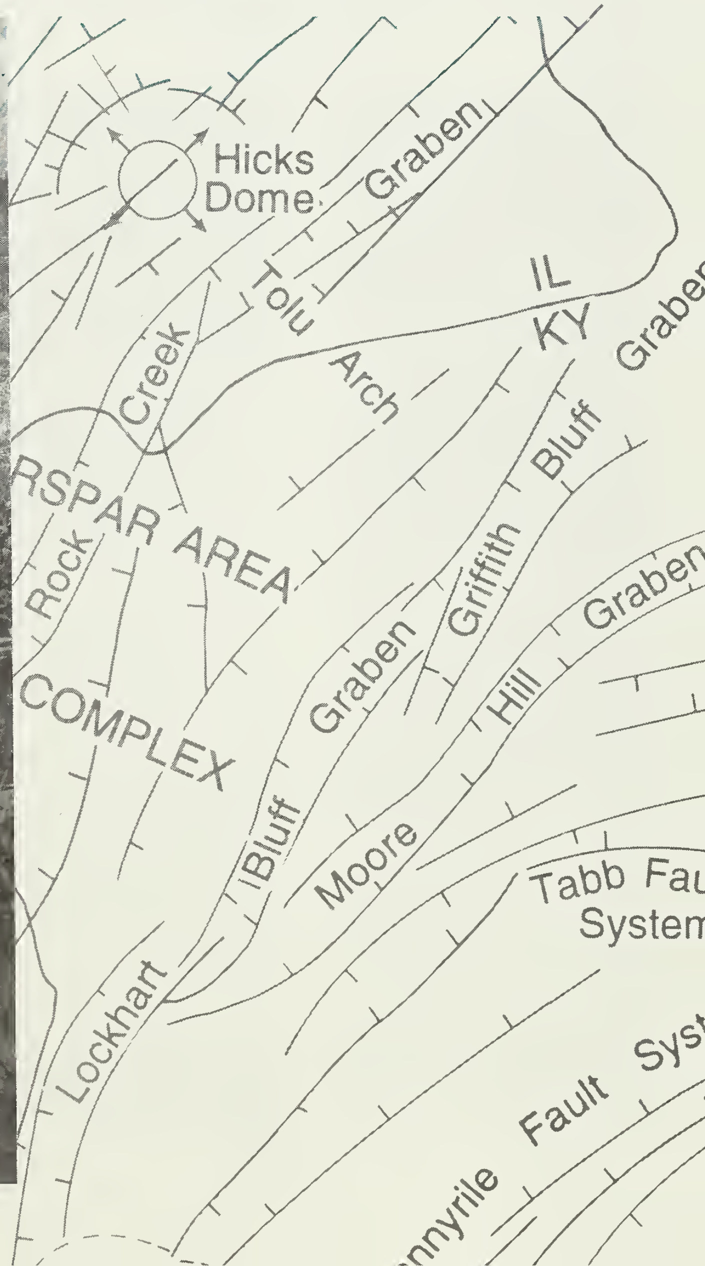
*Illinois Coal Mine Maps and Directories*, 1996 edition

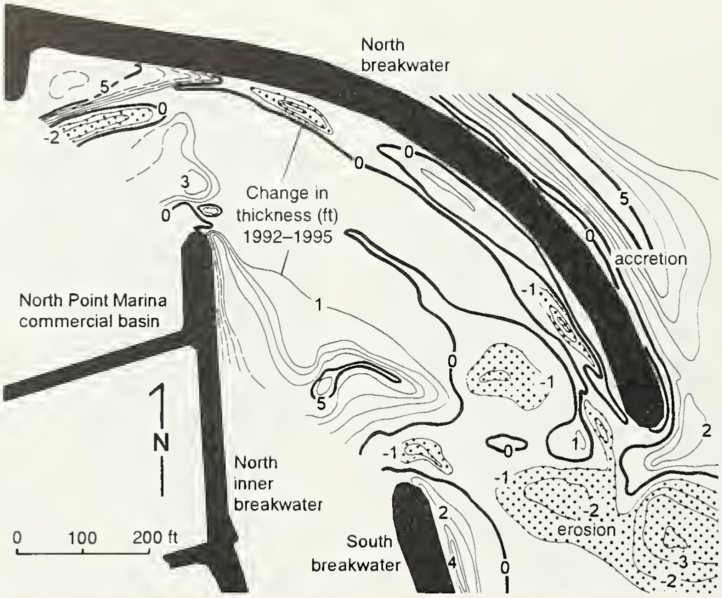
*Mine Subsidence in Illinois: Facts for Homeowners*, ISGS Environmental Geology 144, 1993

# Earth is always changing

*"Dust blowing. Flooding. Earthquakes and landslides. All the geologic processes impact us—in the pocketbook, if nothing else," says environmental geologist John Kempton (now emeritus). Phrases like "everlasting hills" and "rock solid" give people the wrong idea about geology. "We can't take stability as the norm."*

Sinkhole in karst terrain, Monroe County






## Coastal geologists help save State's Lake Michigan beach

*Mike Chrzastowski*
*Tony Foyle*
*Brian Trask*

Along the 15.6 kilometers of Lake Michigan shore between the Illinois–Wisconsin state line and Waukegan Harbor, the sands are never still. Their removal from one place to another is more rapid, more extreme than along any other stretch of Illinois coast.

No one is more concerned than the people at the Illinois Department of Natural Resources (DNR), managing 10.4 kilometers of the shore at North Point Marina and Illinois Beach State Park.

Erosion and accretion in this dynamic coastal environment are being monitored and mapped in a 4-year study by DNR's GeoSurvey. Coastal geologists are working on a framework for the conservation of sand resources along the beaches and lake bottom.

In spring 1996, they reported their preliminary data for beach "nourishment"—to replace the sand washed away by waves.

*Erosion and Accretion Along the Lake Michigan Shore at North Point Marina and Illinois Beach State Park*, ISGS Open File Series 1996-1, 1996

## Tracking sand migration at Forest Park Beach

*Mike Chrzastowski*
*Brian Trask**

Construction along Lake Michigan interacts with waves, currents, and ice. Often the result is undesirable accretion or erosion of beach and lake-bottom sand. That's the reason for DNR's watch (through the Office of Water Resources) on what happens to the coastline near any new construction.

In spring 1996, the GeoSurvey's coastal geologists finished 5 years of studying and mapping the beach and lake bottom at Forest Park Beach, where a 22-acre lakefront park was completed in 1987.

The new recreational facility, built by the city of Lake Forest, was also designed to protect shoreline. The GeoSurvey's geologists confirmed that the facility is doing the job—protecting the shore without causing erosion elsewhere.

Local coastal management will get a big boost from the 5-year's worth of data on migration of sand.

** Foyle, Nowakowski, and Mulvey*

*Review: Lake Forest's Final Report for the 1995 Beach and Nearshore Monitoring*, ISGS Open File Series 1996-6

## Critical intersection—where surface and groundwater meet

*Dick Berg*
*Don Keefer*

A "call to action" came from the U.S. Environmental Protection Agency to evaluate vulnerable watersheds where surface water and groundwater interact. The worry is that surface drinking-water supplies could be adversely affected by contaminated groundwater.

Responding, the Illinois State Geological and Water Surveys worked out a methodology and conducted a statewide study.

Low-flow data for more than 200 watersheds and stream segments throughout Illinois were compared with information on soils, slope, and aquifers less than 50 feet deep.

The results: high recharge from heavy rains percolating into highly permeable soils produces unusually high flows in low-flow watersheds. But groundwater moves more quickly where aquifers lie less than 50 feet below the surface.

*Statewide Goundwater/Surface Water Interactions*, ISGS/ISWS report to Illinois EPA, 1996: Berg, Keefer, Demissie, Ramamurthy

## Storm sewer stealing water from city's park pond?

*Steve Benton*
*Allison Meanor*
*Mike Miller*

In autumn 1995, the water level in a city park pond in Cary, McHenry County, dropped lower than anyone had ever noticed before.

A remote camera survey of a new storm sewer that the Illinois Department of Transportation (IDOT) had installed along Route 14 (Northwest Hwy) in the summer showed groundwater seeping into the sewer.

The Illinois GeoSurvey was asked to investigate, starting in February 1996. Was the storm sewer affecting pond levels?

After 3 months of monitoring surface and groundwater levels, geologists were not convinced that the storm sewer was capturing flow from the pond.

To settle the issue, the Cary Park District and Harza Engineers joined IDOT and the GeoSurvey in August for a second look at the situation.

*Effects of Storm Sewer Installation on Local Water*, Annual Midwest Groundwater Conference, Abstracts with Programs, 1996: Benton

## Zirconium in Kaskaskia river system

*Rich Cahill*
*Bruce Rhoads*

How do rivers move sediments around? What are the best places to sample for suspected contaminants?

Start at stream confluences, channel margins, and point bars, say river researchers. Studying the upper Kaskaskia river basin, scientists from the GeoSurvey and the University of Illinois pooled their knowlege of river dynamics to plan the sampling pattern.

They found higher-than-normal concentrations of chromium, nickel, silver, and zirconium in sediments near Kaufmann Park in west Champaign.

Chemical analyses revealed that fine sand contained the largest concentrations of metals, including up to 24% zirconium, a trace element. The source of the sand could be a local alloy-casting operation.

Fine sand moves mainly as bedload, just above the stream bed. So dispersal of these inert industrial substances is as fluid and far-reaching as the river.

*Network Scale Variability of Trace Metals in Fluvial Systems* (abstract), Association of American Geography Annual Meeting, 1994

## Ground beneath wildlife area gets careful attention

*Mike Barnhardt*
*Chris Stohr*
*Paul Jahn**

In the 1980s, a 100-acre fish and wildlife sanctuary in Bureau County was covered with tons of sediment dredged from nearby Depue Lake, which had been contaminated with high concentrations of heavy metals and other pollutants from a local zinc smelter. The smelter shut down in the 1960s and is now a Super Fund clean-up site.

Survey geologists sampled and chemically analyzed the dredge spoil. They made 26 borings, collected more than 100 samples, and conducted more than 300 organic and inorganic compound analyses.

High levels of zinc and cadmium were found in several samples of the dredge spoil, and a map was produced to show their distribution. The results are being used to determine whether more sampling or clean-up is necessary.

**Benton, Cahill, and Salmon*

## Restoring water and plants to Hickory Grove fen

*Jim Miner*
*Christine Fucciolo*
*Rich Cahill*

Water levels and rare plant species may be restored at the Hickory Grove fen, if field tiles are removed and ditches are filled.

Groundwater specialists from the Illinois GeoSurvey collected soil samples from 23 borings to get a sense of the local earth materials, and installed 29 monitoring wells to measure groundwater levels.

They discovered low water levels near a ditch along the fen's north end and in a part of the fen that is tiled. In the drained areas, plants that tolerate drier conditions have replaced the rare fen plants.

This research was conducted to help IDOT replace wetlands destroyed when building highways.

*Hickory Grove Potential Wetland Mitigation Site: Final Hydrogeologic Characterization Report*, ISGS Open File Series 1996-7

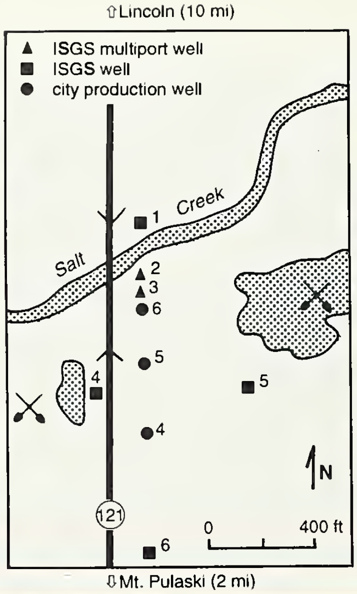
## Mapping helps DNR plan new recreational park

*Don Luman*
*Mike Barnhardt*
*Chris Stohr*

Effective land and resource management at DNR's largest recreational park requires a detailed profile of the earth material beneath it. Called Site M, the park is now under development in Cass County.

In September 1995, the GeoSurvey began mapping the soil characteristics at Site M to locate areas most susceptible to erosion. Using historic and recent aerial photography, geologists are studying present and past land management practices in the Panther and Cox Creek watersheds, of which Site M is a part.

The study has identified a large slump block that occurred about 1969 along Panther Creek. The slump is indicative of severe erosion occurring within the watersheds.




## Agrichemicals in groundwater on the drainage tile express

*Don Keefer*
*Bill Dey*
*Ed Mehnert*

Drainage tiles rid fields of water after heavy rains. But water isn't all that rushes along the tile.

About 50 acres of tile-drained soil in central Illinois came under study when Illinois GeoSurvey researchers decided to sample tile discharge for agrichemicals.

They installed an automatic water sampler and a battery of other instruments that kicked in every time it rained. From late May to June 1995, they collected more than 300 samples. Sure enough, they found nitrates and other chemicals.

What's more, the data suggested that some water was moving through the soil and into tiles up to 1,000 times faster than hydrologic models predicted. That's because the models don't account for the rapid flow of rainwater through cracks, root holes, and animal burrows in the soil.

Groundwater speeding into the nearest aquifer also speeds anything in it to the same destination. In the jargon of geologists, drainage tiles may be preferential flow paths for chemicals.

*Characterization of Field-Scale Preferential Transport of Solutes in a Tile-Drained Soil,* Proceedings, Illinois Groundwater Consortium, 1996

## Do floods wash agrichemicals into alluvial aquifers?

*Jim Risatti*
*Ed Mehnert*
*Georg Grathoff*

When streams flood farm land, could atrazine and nitrate enter underlying aquifers that supply drinking water?

Observation wells were installed in well fields operated by the cities of Mt. Pulaski in Logan County and Henry in Marshall County. Both fields tap aquifers directly connected to streams—hence the term, *alluvial* aquifers.

At both sites, concentrations of atrazine in the stream were low, except during spring floods, when concentrations exceeded the Illinois Environmental Protection Agency's drinking-water standard. The concentration of atrazine in groundwater was never higher than the standard.

At Mt. Pulaski, the concentration of nitrate in the groundwater was lower in water flowing under a forest on the stream bank than it was in groundwater elsewhere. The riverbank forest keeps the nitrate below IEPA's drinking-water standard. Otherwise, the city would have to install expensive water treatment equipment to remove nitrate.

*Transport and Fate of Agrichemicals in an Alluvial Aquifer during Normal and Flood Conditions*, Proceedings, Illinois Groundwater Consortium, 1996

## Spilled pesticides get no farther than the parking lot

*William Roy*
*Joe Chou*
*Ivan Krapac*

Pesticides are sometimes spilled in gravel parking lots and loading areas at agrichemical facilities. Are these chemicals likely to contaminate the soil or leach into groundwater?

GeoSurvey chemists (with the backing of the Illinois Groundwater Consortium) decided to experiment in a controlled setting.

They built their own parking lot: 9×9 meters of gravel over a 1-meter-deep test cell, fully lined and backfilled with soil. The lining would keep the formulated atrazine that researchers deliberately spilled on the gravel from escaping the experiment.

One year later, gravel fill and soil samples have been collected and analyzed. The geochemists have their first results, which support what they found the year before, when they sampled actual parking lots of agrichemical operations.

Most of the spilled pesticide remained in surface gravel. Little atrazine has leached into the soil beneath the fill.

*Fate and Transport of Atrazine in Fill Materials at Agrichemical Facilities: An Update*, Proceedings, Illinois Groundwater Consortium, 1996

## Pesticides served on gravel, tasty treat for bacteria

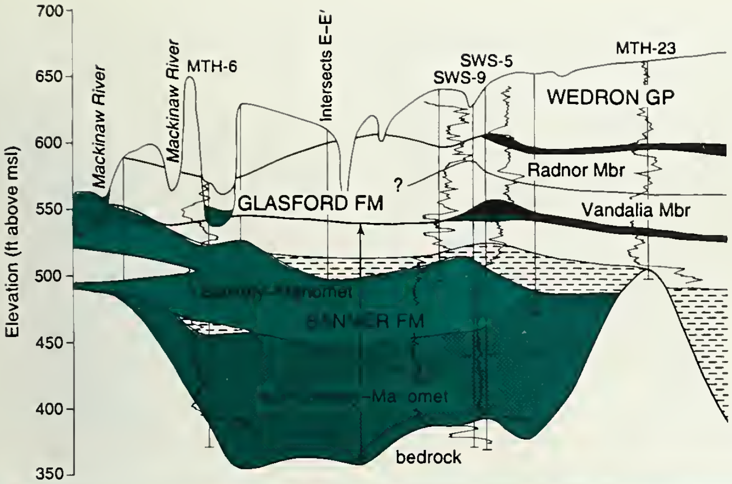
*Joe Chou*
*William Roy*
*Ivan Krapac*

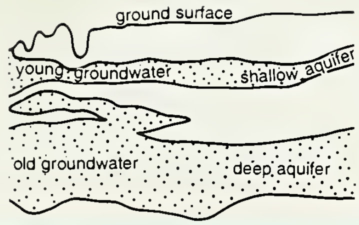
Take cornmeal, mix it with a detergent-like material and fertilizer, spread it generously over the gravel fill used in parking lots—and you have a tasty treat for the bacteria that live there.

If you operate an agrichemical facility, where pesticides are occasionally spilled, you'll be glad to learn the results of the GeoSurvey's experiment.

After 8 weeks, native bacteria in gravel fill had degraded much of the atrazine in three different samples of fill materials, each amended with the mixture of cornmeal, surfactant, and fertilizer. Decreases were 74%, 63%, and 55%.

Results were similar for alachlor and metolachlor. GeoSurvey researchers may have found the way to clean up after a pesticide spill.





## Untapped source for Irrigation—Princeton Bedrock Valley aquifer

*Dave Larson*
*Bev Herzog*

In the Green River Lowland, a broad sand plain in northwestern Illinois, melons and green beans as well as corn and soybeans thrive—thanks to irrigation. So facts on the size and yield of the sand and gravel aquifers are critical to the Lowland's agricultural economy.

Two aquifers were identified in the GeoSurvey's water well records and geophysical logs of test holes drilled for the Water Survey's companion study.

At land surface over most of the area lies the 50-foot-thick Tampico aquifer. It's "unconfined" because no cover of fine-grained, clayey sediments seals it off. Rainwater percolates directly in from the surface.

The deeper aquifer, 150 feet of sand and gravel in the Princeton Bedrock Valley, is separated from the Tampico by 25 to 50 feet of fine sediments nearly everywhere in the Lowland. In a small area to the west, they form one high-yielding aquifer.

*Hydrogeology of the Green River Lowland and Associated Bedrock Valleys in Northwestern Illinois*, ISGS Environmental Geology 149 1995: Larson, Herzog, Vaiden, Chenowith, Xu, Anderson

## Sankoty–Mahomet Sand aquifer—one of the largest in Illinois

*Bev Herzog*
*Dave Larson*
*Ed Smith*

Two buried valleys, carved in bedrock and filled with sand and gravel in the days of glaciers, meet under southwest McLean and southeast Tazewell Counties. These deposits form the Sankoty–Mahomet Sand aquifer, one of the largest in Illinois.

Could the aquifer support a well field yielding 5 to 20 million gallons of water per day?

In a joint study, the Illinois Geological and Water Surveys put the aquifer to the test: 29 holes were drilled to check materials down to the bedrock, and seismic refraction surveys along 45 miles of road showed where the aquifer is thickest.

Well-water levels, rainfall, and local streams went into the calculations. They discovered that water from shallower aquifers leaks into the Sankoty–Mahomet Sand. Groundwater recharge (replenishment of water) to the aquifer amounts to 50 million gallons per day for the whole study area; 60% of that water is available to wells.

*Hydrogeology and Groundwater Availability in McLean and Tazewell Counties*, ISGS/ISWS Cooperative Groundwater Report 17, 1995: Herzog, Wilson, Larson, Smith, Larson, Greenslate

## Old and "new" water mix in Mahomet Bedrock Valley aquifer

*Keith Hackley*
*Sam Panno*
*Jack Liu*

The Mahomet Bedrock Valley aquifer in central Illinois is replenished both by rainfall and upwelling of old water from the underlying bedrock.

Geochemists in the Isotope Geochemistry and Hydrogeology Labs drew these conclusions after studying the chemistry and radiocarbon data of samples collected from the aquifer.

In its center near northeast Champaign County, rainfall percolating down from the surface (albeit very slowly) is the main source of recharge, that is, water entering the aquifer. The carbon-14 age of water in the central aquifer is about 3,000 radiocarbon years before the present (RCYBP).

Elsewhere in the aquifer, groundwater is believed to be a mix of relatively new and very old water. These samples all show significantly older carbon-14 ages, ranging from about 8,000 to 15,000 RCYBP.

## Flood-prone village searches for new water supply

*Tim Larson*
*Steve Sargent*
*Tim Young*

After the second major flood on the Kaskaskia River this decade, Evansville no longer wants to rely on the river for drinking water. To find an underground water supply, the Randolph County river town turned to the Illinois GeoSurvey.

Geologists conducted 19 seismic refraction profiles and 77 electrical earth resistivity tests to locate water-bearing earth materials (technically called an aquifer) in the Evansville area. The tests identified three promising sites north of the town for exploratory test drilling. Drilling starts this fall to determine if the aquifer meets Evansville water needs. The town's goal is to have a safe, secure municipal well in place before the river jumps its banks again.

*Preliminary Geophysical Investigation of the Sand and Gravel Aquifers in the Kaskaskia River Valley near Evansville, Illinois*: ISGS Open File Series 1996-4

## Rolling country riddled with sinkholes—don't drink the water!

*Sam Panno*
*Pius Weibel*
*Ivan Krapac*

The sinkhole plain of southwestern Illinois has roughly 10,000 sinkholes. This typical karst terrain is honeycombed with caves and streams in the limestone bedrock just below the surface.

About half the residents of southern St. Clair, Monroe, and northern Randolph Counties rely on wells for drinking water. One-half to two-thirds of the wells and almost all springs are contaminated with unacceptably high concentrations of bacteria. The main reason is that septic fields are too close to the sinkholes, flushing straight into groundwater and wells.

Many residents are abandoning their wells and opting for expensive city water, as soon as it becomes available. Others have switched to post-well, in-line water treatment systems.

The Illinois GeoSurvey is currently mapping the density of sinkholes, and sampling wells and springs throughout the counties.

*Groundwater Contamination in Karst Terrain of Southwestern Illinois*, ISGS Environmental Geology 151, 1996

## Biodiversity and wetland workshops for teachers

*Wayne Frankie*
*Ardith Hansel*

Teachers get to experience real-world science from working scientists when they participate in biodiversity and wetland workshops conducted by the Illinois GeoSurvey and its sister agencies. Geologists, botanists, entomologists, archaeologists, and soil scientists offer teachers a multidisciplinary approach to science they can bring back to the classroom.

At the wetland workshops, such as those held at Volo Bog in McHenry County and Heron Pond in Johnson County, teachers learn the criteria for identifying wetlands and about wetland flora and fauna. They learn to interpret geologic and topographic maps, describe soil samples, and collect aquatic animals of all kinds.

At the biodiversity workshops, held in conjunction with a permanent travelling exhibit on biodiversity, teachers get an understanding of the interrelationships between living organisms, geological settings, soils, climate, and human activities.

## How-to manual for assessing environmental hazards

*Anne Erdmann*
*Bob Bauer*
*Phyllis Bannon*

Knowing how land was used in the past can tell geologists much about that land's environmental state today. So can field tests to investigate subsurface conditions and site inspections that include interviews with the local people. These are just a few of the steps the GeoSurvey developed to evaluate the environmental condition of land designated by the Illinois Department of Transportation for road construction and improvement.

Considered state-of-the-art by the Federal Highway Administration, the GeoSurvey's assessment procedures differ from the industry standard. Survey geologists have to assess several hundred parcels of land at a time, whereas the environmental industry usually does single parcels.

The procedures are now available to everyone.

*A Manual for Conducting Preliminary Environmental Site Assessments for Illinois Department of Transportation Highway Projects*, ISGS Open File Series 1996-5


## Check out Illinois GeoSurvey online

*Sally Denhart**

Whether you're looking for maps, dinosaur pictures, features on Illinois geology, or earth science educational materials, you can find them and much more on the GeoSurvey's World Wide Web Home Page.

Once you arrive at GeoSurvey online—from wherever you and your computer may happen to be—you can volunteer to dig up dinosaurs, find out where and when is the next Illinois geological field trip, and discover why so many "lakes" are in Monroe County.

The Web site is interactive, flexible, and loaded with the kind of material you can put to use immediately. *National Geographic Online* recently named Jacobson's dinosaur pages a best site, and more than 20,000 visitors worldwide checked us out last year. We expect the number to go up this year. Come see us soon!

**Jacobson, Leetaru, Latimer, Cookus, Coleman, Kuchenbrod, Raymond*

GeoSurvey Home Page at *http://www.isgs.uiuc.edu/isgshome.html*

# Financial report

# Financial report

**Appropriated Funds** The total amount appropriated for FY 1996 was $5,956,000 (General Revenue Fund $5,564,500; Natural Resources Information Fund $250,400; Hazardous Waste Research Fund $141,100). Expenditures from the General Revenue Fund (table F1) totaled 99.96% of the appropriated amount. The Geological Survey experienced shortfalls in the computer based research, telecommunications, and operation of automotive equipment lines. These shortfalls were covered by transfers from other General Revenue Fund operating lines.

A total of $2,400 remained unspent from all the GRF budget lines. Approximately $700 was lapsed as a result of overestimating costs under the operation of automotive expenses line. Approximately $600 was lapsed from the contractual services line as a result of repair work that could not be done by the contractor prior to the end of the lapse period. Approximately $400 was lapsed as a result of overestimating equipment costs and through cancellation of an order placed for a book that turned out to be out of print. Approximately $300 was lapsed as a result of an overestimation of the costs of repairs to be paid from the repair and maintenance of major equipment budget line. Minimal amounts were lapsed in commodities, computer based research, geomapping–other expenses, and water inventory and aquifer assessment.

Expenditures from the Natural Resources Information Fund were held to approximately 68% of the appropriation (table F2). Receipts into the fund from publication sales were lower than the full appropriation amount and expenditures were held to approximately the amount of the receipts. Receipts exceeded expenditures by $2,188.28.

Expenditures from the Hazardous Waste Research Fund (Groundwater Protection Act) were approximately 97.5% of the appropriation (table F3). Receipts paid into the Fund were lower than required to expend the full appropriation amount.

**University-Administered Funds** For the funds generated by the University of Illinois from indirect cost recovery in FY 1996, expenditures were 85.3% of the Board-approved allocations (table F4). Minimal cost overruns were experienced in the contractual services and equipment lines. Transfers among budget lines were necessary, but the planned total expenditure was not exceeded.

**Table F1** FY96 Financial Statement for the General Revenue Fund: July 1, 1995 through September 30,1996 ($ in thousands).

| Line item | Original appropriation for FY96 | Transfers | Vouchered to date | Outstanding obligations to date | Balance available for FY96 |
|---|---|---|---|---|---|
| Personal services | $4,940.4 | $0.0 | $4,940.4 | $0.0 | $ 0.0 |
| Social Security contributions | 19.1 | (1.0) | 18.1 | 0.0 | 0.0 |
| Contractual services | 90.2 | (3.3) | 86.3 | 0.0 | 0.6 |
| Topomapping | 17.4 | 0.0 | 17.4 | 0.0 | 0.0 |
| Travel | 35.7 | (3.7) | 32.0 | 0.0 | 0.0 |
| Commodities | 63.2 | (10.0) | 53.1 | 0.0 | 0.1 |
| Printing | 32.9 | 7.0 | 39.9 | 0.0 | 0.0 |
| Equipment | 34.7 | 0.0 | 34.3 | 0.0 | 0.4 |
| Computer based research | 47.9 | 2.0 | 49.8 | 0.0 | 0.1 |
| Telecommunications | 48.7 | 5.8 | 54.5 | 0.0 | 0.0 |
| Operation of auto. equip. | 31.6 | 3.2 | 34.1 | 0.0 | 0.7 |
| GeoMapping – other expenses | 22.5 | 0.0 | 22.4 | 0.0 | 0.1 |
| Water inventory and aquifer assessment | 85.5 | 0.0 | 85.4 | 0.0 | 0.1 |
| Repair and maintenance – major equipment | 78.4 | 0.0 | 78.1 | 0.0 | 0.3 |
| Repair and maintenance – building | 16.3 | 0.0 | 16.3 | 0.0 | 0.0 |
| Totals | $5,564.5 | $0.0 | $5,562.1 | $0.0 | $2.4 |

**Table F2** FY96 Financial Statement for the Natural Resources Information Fund: July 1, 1995 through September 30,1996 ($ in thousands).

| Line item | Original appropriation for FY96 | Vouchered to date | Outstanding obligations to date | Balance* |
|---|---|---|---|---|
| Lump sum – operating expenses | $249.4 | $170.0 | $0.0 | $79.4 |
| Refunds | 1.0 | 0.1 | 0.0 | 0.9 |
| Totals | $250.4 | $170.1 | $0.0 | $80.3 |

*NRIF receipts were insufficient to expend the full appropriated amount.
NRIF receipts July 1, 1995 through June 30, 1996 were $172,242.83.

**Table F3** FY96 Financial Statement for the Hazardous Waste Research Fund (Groundwater Protection Act) July 1, 1995 through September 30,1996 ($ in thousands).

| Line Item | Available appropriation for FY96 | Vouchered to date | Outstanding obligations to date | Balance available for FY96* |
|---|---|---|---|---|
| Lump sum | $141.1 | $137.6 | $0.0 | $3.5 |
| Totals | $141.1 | $137.6 | $0.0 | $3.5 |

*HWRF receipts are insufficient to expend the full appropriation amount.

**Table F4** FY96 Financial Statement for the Indirect Cost Recovery Fund: July 1, 1995 through June 30, 1996 ($ in thousands).

| Line item | Approved allocation for FY96 | Transfers | Vouchered to date | Outstanding obligations to date | Balance available for FY96 |
|---|---|---|---|---|---|
| Personal services | $31.2 | $(1.3) | $17.5 | $ 0.0 | $12.4 |
| Benefits | 7.5 | 0.0 | 2.7 | 0.0 | 4.8 |
| Retirement lump sums | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Contractual services | 73.0 | 0.8 | 73.8 | 0.0 | 0.0 |
| Travel | 13.5 | 0.0 | 9.1 | 0.0 | 4.4 |
| Commodities | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Printing | 1.5 | 0.0 | 0.0 | 0.0 | 1.5 |
| Equipment | 7.5 | 0.5 | 8.0 | 0.0 | 0.0 |
| Telecommunications | 0.5 | 0.0 | 0.1 | 0.0 | 0.4 |
| Allocations | 97.6 | 0.0 | 86.8 | 0.0 | 10.8 |
| Totals | $233.3 | $0.0 | $199.0 | $0.0 | $34.3 |

ICR income from July 1, 1995 through June 30, 1996 was $232,651.

# Other active research projects

*Activated Carbon to Remove Mercury Flue Gas,* Massoud Rostam-Abadi, Scott Chen

*Organic and Inorganic Chemistry in Natural and Constructed Wetlands,* Rich Cahill

*Advective-Dispersive Model of the Movement of Water and Tritium through an Earthen Liner,* Ivan Krapac

*Identification of Contaminants from Coal Combustion in River Sediments,* Gary Salmon

*Production of Fertilizer from Flue Gas Desulfurization Gypsum,* Melissa Chou

*Effects of Chlorine on Boiler Corrosion,* Melissa Chou

*Hazardous Air Pollutants from Coal Combustion,* Ilham Demir, Gus Ruch, Heinz Damberger, Dick Harvey

*Dug Well Monitoring,* Ed Mehnert, Don Keefer, Bill Dey

*Fate and Transport of Agrichemicals in Saturated-Unsaturated Media,* Manoutchehr Heidari

*Statistical Analysis of Agrichemical Contamination,* Mike Barnhardt, Don Keefer

*Use of Environmental Isotopes to Identify Landfill-Produced Contaminants,* Keith Hackley, Jack Liu

*Geology for Planning in Kane County*, Brandon Curry, Brian Trask, Anne Erdmann, Lisa Smith, Tim Larson

*GeoHazards: a Guide for Homeowners*, Billy Trent

*Earthquake Response Team,* Bob Bauer, Tim Larson, Wen-June Su

*Databases and Maps for Seismic Zonation Studies in the Central U.S. Earthquake Region,* Bob Bauer

*Comparison of Two "Hot Petroleum Plays" in the Williston and Illinois Basins,* Zak Lasemi, Randy Burks

*Low Oil Prices and the Illinois Oil Industry: Effects, Outlook, and Policies*, Subhash Bhagwat

*Enhanced Oil Recovery—Characterization of Minerals,* Randy Hughes

*Sequence Stratigraphy and Resource Extraction in the Aux Vases Sandstone*, Hannes Leetaru

*Geological and Petrophysical Analyses of Sandstone, Crescent City Gas Storage,* Emmanuel Udegbunam

*Cypress Sandstone Characterization in Richview and Lawrence Fields,* John Grube

*Oil Field Discovery Wells: Historical Perspective,* Bryan Huff

*History of the Oil Industry in the Illinois Basin*, Joan Crockett

*Role of Diagenesis in Aux Vases and Cypress Sandstone Reservoir Development*, Bev Seyler, Randy Hughes

*Analysis of Organic Sulfur in Coal,* Chusak Chaven, Kathy Henry, Chris Rohl

*Hydrogeology of the Danville Area,* Dave Larson

*Geologic Records Unit Expands Database,* Alan Metcalf, Anne Faber, Jane Duncan, Kimbra Burris, Tonia Vaughan, Brent Lemke

*Well Database Maintenance and Programming,* Alison Lecouris

*Steady Activity in the Geological Samples Library,* Mike Sargent, Mary Jones, Robert Mumm, Bill Revell

*Curation of Drill Core from Shell Oil and Columbia Quarry,* Zak Lasemi, Mike Sargent, and Dave Morse

*Groundwater Information Requests,* Ross Brower, Bob Vaiden, Bev Herzog, Ed Smith, Dave Larson

*Borehole Logging and Geophysical Service,* Tim Young, Steve Sargent, Tim Larson

*Particle-Size Analysis Laboratory,* Dan Adomaitis

*Digital Cartography for Revision of the Map, Coal Industry in Illinois,* Barb Stiff

*Coalballs and Siderite Concretions Associated with Illinois Coals,* Phil DeMaris

*Precise Determination of the Composition of Individual Minerals*, Randy Hughes, Dewey Moore

*Fingerprinting Illinois Coals,* Russ Peppers

*Illite in the Lower Paleozoic of the Illinois Basin: Origin, Age, and Polytype Quantification*, Georg Grathoff

*Composition and Origin of Sulfur in Illinois Basin Coals,* Chen-Lin Chou, Keith Hackley, Jack Liu

*Pre-Illinois Sediments in Western Illinois,* Myrna Killey

*"Ice Age" in Illinois (Educational Series)*, Myrna Killey

*Geosol Investigations at Athens Quarry,* Leon Follmer

*Initial Geologic Assessment of the Rock River Resource-Rich Area,* Don Luman, Mike Barnhardt, Dick Berg, Subhash Bhagwat, Don Mikulic

*Geology and Mapping: McHenry County,* Brandon Curry, Dick Berg, Bob Vaiden, Dave Grimley

*Pennsylvanian Ichnofossils of the Illinois Basin,* Joe Devera

*Estimation of Parameters for Local and Regional Aquifers,* Manoutchehr Heidari

*Hydrogeologic Terranes of Illinois*, Ed Smith

*Bedrock Topography and Drift Thickness of Will and Southern Cook Counties*, Ed Smith

*Clay Mineralogy for Mapping the Villa Grove and Vincennes Quadrangles,* Herb Glass

*Surface Expression of Subtle Fault Features,* Chris Stohr

*Geology of Tunneling for Future Accelerators at Fermilab,* Dave Gross, Bob Bauer, Janis Treworgy

*Deep Structure of Earth's Crust beneath Folded Rocks: Possible Earthquake Source,* John McBride

*Neotectonic Faulting in Southernmost Illinois,* John Nelson, Joe Devera, Jack Masters

Cottage
Monocline
Grove
IL
MO
fault of Devonian age
Ste. Genevieve Fault Zone
Fault Zone
Pomona Fault
Bodenschatz - Lick
OZARK
DOME
Scopus
Jackson Fault Zone
approximate edge of Mississip
IL
MO